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Specialized information is presented for those involved in assuring improvement in the outdoor physical education facilities of the future. The materials included are intended to be useful to architects, engineers and designers generally; program specialists, administrators and consultants in education; and students preparing for professional careers in physical education. Specific chapters discuss the following topics--(1) comprehensive planning, (2) planning objectives, (3) site selection, (4) common problems of space utilization, (5) the orientation of outdoor physical education facilities, (6) physical education play surfaces, (7) sports lighting, and (8) service facilities. (RK)

FACILITY DESIGN

[Outdoor Physical Education Facilities for Colleges and Universities]

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THE DESIGN

of Outdoor Physical Education Facilities for Colleges and Schools

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EDITOR'S INTRODUCTION

This is one of a series of monographs dealing with selected aspects of educational plant planning that are published under the sponsorship of the Institute of Field Studies, Teachers College, Columbia University. The several monographs are based on reports of individual research projects undertaken by graduate students at Teachers College as part of their programs of studies leading to the Doctor of Education degree. The respective authors are men who have broad knowledge of the areas they write about, and their intensive studies of these areas should give readers new insights, ideas and suggestions concerning the planning of specialized aspects of the educational plant.

This volume, prepared by Dr. James B. Delamater, under the direction of Dr. Harry A. Scott, Professor Emeritus of Health and Physical Education at Teachers College, Columbia University, deals with the broad problem of designing outdoor physical education facilities, often commonly referred to as play fields or playgrounds. A review of this monograph will quickly point out to the reader that this topic is far from simple, and this is particularly true when the extensive needs of colleges and universities are considered. While Dr. Delamater was primarily concerned with the needs of educational institutions, it may be pointed out that his findings and conclusions can be applied to both public and private outdoor recreational areas. This project deserves serious study by school, college and public officials, architects and engineers faced with the problem of developing outdoor physical education and recreational facilities.

Henry H. Linn

AUTHOR'S PREFACE

There is general agreement among educators that superior facilities enhance educational programs. Furthermore, there is universal agreement that superior leadership is the principal ingredient needed for consistent progress in any form. This monograph is dedicated to the task of presenting the specialized information required by the leaders involved to assure improvement in the outdoor physical education facilities of the future. The materials included are intended to be useful to architects, engineers and designers generally; program specialists,administrators and consultants in education; and students preparing for professional careers in physical education.

These materials are presented on the basis of three specific assumptions. The first of these involves the belief that the design and evaluation of educational facilities is a continuous responsibility of the professional educator. There must be provisions within the administrative organization of a school system or college to assure systematic and thorough coverage. Furthermore, the functional design of educational facilities requires a major cooperative undertaking in which competent representatives from several professions pool their specialized knowledge and experience in the solution of a common problem. Because of this initial assumption, a major section of this publication is assigned to the topic of comprehensive planning and its methods and materials.

A second assumption is based on the belief that the initial and continuing responsibility for the design of facilities to be used in a specific program rests with the professional educators who are specifically responsible for the program involved. The program specialist as herein used refers to the professional physical education specialist. Because of this responsibility, it is necessary for the physical education professional to establish practices which will prepare him for the tasks involved in the design of the facilities required for maximum accomplishments in the areas of his specialty. These practices are described, and summary descriptions of the contributions which other professionals who should be involved in the comprehensive planning required for the efficient design and development of outdoor physical education facilities are included.

Finally, it is assumed that no ready-made prescriptions exist for use by the program specialist, the architect and others responsible for designing educational facilities. Therefore, the necessity for designing facilities which are "custom-made" for the specific program to be served is emphasized throughout the publication. Standards are proposed as information helpful to local authorities in their effort to devise specific measures of qualitative and quantitative sufficiency for the programs and facilities they require. Such standards are also helpful to local planners because they indicate national trends and "averages". As such they tend to guard against mistakes of over-emphasis as well as those of under-emphasis in local programs and practices. Their true value, however, is limited to the manner in which they are used and adapted to fit local conditions and to serve local programs.

It is the sincere desire of the author that this compilation of theory and practice will contribute in a small way to the progress of the profession, and that it will provide helpful assistance to those who use it. The author is indebted to many persons and organizations for the help they have provided. A specific debt of gratitude is owed to the writers and publishers who have so generously permitted their materials to be used, and especially to Professor Emeritus Harry A. Scott who originally stimulated an interest in this project and who continually encouraged and assisted in its completion.

J. B. D.

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CHAPTER I

COMPREHENSIVE PLANNING

Problem solving is an energy-expending and time-consuming responsibility which rational man has been learning to accept during his entire existence. It embodies the process by which man is enabled to improve his lot on earth, and includes most of those activities of man which become necessary in his effort to satisfy his personal needs and to carry out his various responsibilities. Man usually expends his time, energy, and other resources long before he satisfactorily solves all his problems. As a result, many of the solutions he accepts fall far short with respect to the standards for excellence to which he aspires.

The problems encountered by the educator in his efforts to discharge his responsibilities with respect to educational facilities are numerous and complex. Recording decisions for the long-range future is a hazardous business at best. The magnitude of the task is all the more awesome when one considers that decisions which affect educational facilities must stand for the entire life of those facilities--a period of from 20 to 50 or more years. The fact that these facilities so frequently are inadequate to serve the program for which they are intended attests to the complexity of the problems encountered. This fact also emphasizes the urgency for initiating and utilizing efficient methods for considering these problems on a systematic, continuous, and long-range basis.

The discussion of comprehensive planning which follows aims to suggest a purpose and to recommend procedures which may be utilized in planning the development of the physical plant for American educational institutions, with special emphasis on the outdoor physical education program.

The Planning Process

Any individual who has been involved in the total process of design, construction, and operation of any educational facility is well aware of the complexities of the undertaking. Among home owners the thought is prevalent that one must design and build several homes before the ideally suited one is obtained. Such a realization is based on the philosophy that each home owner cannot escape the costly and inefficient process of trial and error in designing and constructing his home. Since the money and effort involved in the design of a private home are usually private matters, this can be considered the private business of the home owner. Public facilities, on the other hand, are financed by public money. Responsible administrators are expected to exercise effective precautions to avoid the mistakes which result from trial and error methods.

In these days of expanding populations and changing conditions, practically all programs of public service are being enlarged. Those who administer these programs are faced with the constant responsibility of providing the effective leadership needed to house and staff such programs. All too frequently the methods utilized by administrators in their efforts to discharge their responsibilities relative to the facilities needed fall short in some important aspect.

The provision of superior educational facilities requires the expenditure of large sums of money. As a result, they must be used over long periods of time. When errors and omissions are made in the design of such facilities, the programs for which they were intended are hampered until corrections are made. It is important, therefore, that every precaution be taken to prevent such costly inadequacies.

It is true that many practices can be utilized successfully in devising an adequate plan for the solution of any specific problem. When the problem happens to be the design of educational facilities, there are some important considerations such as:

1. Since even the most comprehensive plans require frequent revision to meet situations which are constantly changing, planning should be conducted on a continuous basis. It should be initiated well in advance of anticipated need, and it should continue indefinitely.

2. Since the facts which are pertinent in a planning task frequently involve several related fields of specialization, individuals of experience, intelligence, and competence from each of the fields involved should be enlisted in designing and executing the plan.

3. Because situations for which plans are devised differ, it is important that a plan be formulated with the specific situation for which the plan is intended clearly in mind.

Included in this cursory resume of the planning process are the basic concepts of this chapter. It is assumed that social institutions in a democratic society should provide stimulating leadership in an effort to increase the efficiency of the long-range planning of individuals and groups. If such leadership is to be forthcoming, these institutions should provide in their own planning efforts numerous opportunities for many individuals to gain valuable experience through observing and participating in planning which is of a high order of excellence. Such planning should be undertaken on a continuous basis in order to assure superior plans well in advance of urgent need, while providing at all times for the revisions which an ever-changing society demands; it should be based on the combined knowledge and experience of many individuals, each of whom has something important to contribute to the design and execution of the plan; and it should be devised for a specific situation and for specific individuals. The latter requirement condemns the common practice of adopting the plans of other communities and educational units and attempting to implement them, without necessary revision, into a setting which is different in many important respects. It also limits the value of widely accepted standards of sufficiency for facilities needed in educational programs. Such standards should be designed as guides and used for reference purposes by intelligent and well-informed individuals who are familiar with the local educational program and the many factors which influence sound decisions relative thereto. When such standards are accepted blindly by educational planners, some aspects of the local educational program are sure to suffer.[1]

[1] Appendix A includes generally recognized standards which are helpful in formulating local decisions.

The suggested institutional organization plan for plant development which follows reflects these basic concepts and outlines one method by which they can be utilized efficiently with respect to the functional design of outdoor physical education facilities.

Institutional Organization For Plant Development

Effective long-range planning for outdoor physical education facilities usually can be accomplished most efficiently when this effort is but one part of an organization-wide program for plant development. When such is the case, a pattern for action within the organization usually exists, and authority and responsibility for action are allocated.

Educational planning is an executive responsibility. Because, however, the educational program of a community is so complex, because it affects so many individuals and individual efforts in a community, and because its many aspects and ramifications are so far-reaching and widespread, it is increasingly apparent among educators that no single person or official can be expected to understand and deal effectively with its many requirements. Among administrators in education, therefore, cooperative planning methods are being endorsed. Naturally, the characteristics and the extent of the methods utilized will vary, depending on the local situation and the philosophy of the administrator.

An Institutional-Policy Committee -- To plan effectively for any specific educational program, certain basic, long-range decisions must be formulated and recorded in order to point out the general direction in which an institution may be expected to go 5, 10, 20, or 50 years in the future. These decisions should be made on the basis of the best and most complete information available at the time they are made, and they should be considered tentative and subject to immediate and continuous revision as circumstances in the future reveal the need for change. In each educational institution there are represented, in various offices of administration, faculty, and staff, individuals whose education and experience especially qualify them to contribute valuable service in the formulation of these important long-range decisions.

Many competent administrators find it desirable to call on such individuals to compose an institutional-policy committee. Because the policies recommended by such a group influence the scope and nature of the educational program for the entire institution, the committee should have at least one competent representative from each school or department of the institution. This committee, among its functions, would have the following responsibilities relative to plant development:

1. To evaluate the broad institutional practices and programs already in operation, and to make recommendations contemplated to assure continuous progress for the institution.

2. To devise the educational requirements for each part of the institutional program, and to assure wide dissemination of information relative to them.

3. To recommend institutional policy relative to ultimate quantitative and qualitative growth.

4. To make recommendations necessary to assure continuous long-range planning in important areas, such as the development of the physical plant.

An Institutional Plant-Development Committee -- Plant development is an important administrative responsibility frequently delegated to an appointive committee which may be charged with the task of formulating a comprehensive, long-range plan designed to show how the contemplated educational program of an organization is to be housed in the immediate, as well as in the far-distant future.

An institutional plant-development committee should function on an organization-wide basis and usually requires the formation of subsidiary working groups within each department or school. Such groups would be charged with the responsibility of providing the detail necessary to assure that facilities developed for an educational program will embrace the features necessary to make them functionally useful for that specific program. The following duties may be performed by such a committee:

1. Determine present and ultimate requirements for the physical plant.

2. Determine what special plant-development committees can be utilized effectively, initiate their formation, and decide as to their specific functions.

3. Determine how committee work should be initiated, and assist by furnishing the reference materials and consultative help needed to expedite such work.

4. Formulate the basic sequence for planning operations, and devise a tentative time schedule for the various stages of plant development.

5. Supervise the evaluation of plant-development plans and specifications.

6. Make recommendations concerning the issuance of contracts, and supervise construction procedures.

7. Evaluate completed facilities.

A Plant-Development Committee For Physical Education -- Special plant-development committees may be formed for the purpose of contributing to the total institutional plant-development program by providing functional detail for facilities needed for specific programs. One of these committees should be utilized to determine plant requirements for the physical education and recreation programs. Usually the membership of this committee will include all professional members of the departmental staff. In addition, the institutional planning officer and representatives from other departments, including maintenance, should be consulted when their services may contribute to the solution of a specific problem.

The responsibilities of the plant-development committee for physical education may be summarized as follows:

1. To conduct a comprehensive study of institutional policy affecting the program of physical education to be developed, including such factors as:

a. Institutional curricular requirements for students in physical education which indicate the minimum number of facilities needed to conduct the required program.

b. Emphasis on both required and voluntary aspects of the physical education program.

c. Scheduling practices, including the size of classes and the number of class periods to be utilized.

d. Anticipated maximum student enrollment.

e. The type and extent of other educational programs which influence the amount of free time available to students for voluntary participation in physical education activities.

f. Staff-student ratios as they are to be used in estimating the number of staff members available to conduct the program.

2. To formulate, on the basis of the above study, a detailed description of the program to be served by the physical plant.

3. To make long-term estimates of the number of participants to be served by all physical education facilities during periods of maximum participation.

4. To determine on the basis of these estimates the number of facility units (teaching stations) needed to serve the program.

5. To conduct a comprehensive study of the space allocated or available for physical education, and to make recommendations as to the fitness of this space to house the program.

6. To provide a list of the desirable and undesirable features of facilities observed at other institutions.

7. To develop a detailed description of the functional features required in each facility unit needed.

8. To work with the architect throughout the entire planning period, including the final evaluation of the completed facility.

9. To provide reference material which may aid committee members, architect, and contractor in obtaining a complete understanding of the functional features of facilities being planned.

The administrative organization described above is designed to carry out the long-range planning functions for plant development for educational institutions. Other methods may prove equally successful. Whatever the method, however, the comprehensive coverage of the many details involved in designing and constructing functionally efficient educational facilities requires a well-conceived organizational plan. The functions and

responsibilities outlined for each of the three planning groups involved in the proposed method are important, and any plan utilized should provide for competent and thorough consideration of each of them.

Planning Specialists

Although an effective organization enables and encourages people to carry out their delegated duties expeditiously, in the final analysis those who devise and execute the plan determine the final measure of its success. The detail which must be considered if plant development is to be carried out efficiently usually cuts across several specialized fields of endeavor. If this multitude of detail is to be handled thoroughly and competently, it is important that a representative from each of the specialized areas concerned be consulted during the planning process. Under normal conditions, when outdoor physical education facilities are being planned, many or all of the following specialists will have important contributions to make to the plan.

The Administrative Head -- All members of the planning task force should realize that the administrative head of an educational institution, as the chief executive officer of the board of control of that institution, is immediately responsible for insuring that all facilities needed in carrying out the educational functions of the institution are provided. It is becoming increasingly apparent, however, that no single individual can possibly give personal attention to all aspects of all administrative functions. With this realization has come the necessity for developing administrative procedures designed to ease the burden of the educational executive. It is recognized that through such measures the chief administrative officer may delegate certain of his duties to members of his staff, thus charging them with the responsibility of providing adequate solutions and recommendations. Such designated assistants must answer to the chief executive for the manner in which they discharge their delegated duties, and in the final analysis all action taken is the responsibility of the administrative head.

More specifically, the administrative head of an institution is responsible for:

1. Evaluating existing facilities for all institutional programs, and determining when and by what means such facilities shall be improved, enlarged, or increased in number and in kind.

2. Testing the adequacy of the site on which present and future institutional functions will be conducted, and providing the leadership required to supplement this site by acquisition of additional land in advance of urgent need.

3. Inaugurating the means necessary to develop plans and specifications which will assure an orderly and efficient development of the facilities needed for the long-range program.

4. Providing the leadership required to assure the availability of necessary funds, as needed.

5. Exercising control throughout all stages of the planning task to lend assurance that each completed facility will possess the desirable features specified, insofar as available funds permit.

The professional competence and dynamic leadership abilities of this official are absolutely essential if efficient administrative procedures are to be developed and utilized throughout the departments of the institution. Without this competence and leadership, it is possible for individual departments and programs to function at a high level of efficiency, but it is difficult for the institution as a whole to function in such a manner.

The Program Specialist -- That person who knows most about the program to be served by a specific facility is referred to herein as a program specialist. The chairman of the department or any staff member may be thus classified when, through education, experience, and interest, he gains a thorough understanding of a specific activity or a specialized area. Through such an understanding, this specialist is ideally qualified to point out the functional features needed in a facility for high efficiency. It is difficult to overemphasize the responsibility of the program specialist in any planning effort. A large percentage of the errors discovered in physical education facilities can be traced to a failure on the part of planners to consult competent specialists on program requirements. Unfortunately, it must be admitted that many mistakes also must be charged to incompetencies on the part of the program specialist consulted. There is an ever-growing source of information within the literature of the field to aid members of the profession in their efforts to achieve the competence they desire in this specialized area of knowledge. Courses at the undergraduate and graduate levels are being offered; programs at professional gatherings are devoted to consideration of the most pertinent current problems in this area; workshops have been organized; and major publications have been devoted to this specialization within the field.

The program specialist may rightfully be concerned with all aspects of the activity prescribed for the plant development committee for physical education as previously described. In summary, these responsibilities are:

1. To provide for the institution the leadership required to enable its policy-makers to establish sound, long-range policies to guide the institution in its immediate and long-term physical education efforts.

2. To describe the present and future physical education program in minute detail and to outline the immediate, intermediate, and long-range action which must be taken if the program is to progress as pictured.

3. To provide an analysis of present and future participation in the various aspects of the program of physical education based on present and anticipated enrollment data for the institution as a whole.

4. To develop a detailed analysis showing how, when, where, and under whose supervision these students will participate.

5. To estimate the number of facility units (such as tennis courts, softball fields, etc.) needed for each activity in the physical education program, and to recommend a time schedule for the development of these facilities.

6. To develop a detailed description of the functional requirements needed in each facility to insure its present and long-term validity and usefulness.

7. To make available and to be ready to interpret for the designer additional authentic information on the functional aspects to be incorporated in the facilities designed.

8. To be persistently available throughout all stages in the development of new physical education facilities including pre-planning, planning, construction, use, and evaluation of the facility in use.

As a professional person it will be obvious to the program specialist that many activities in the planning process for physical education facilities rightfully fall within the realm of his specialty. It will be equally obvious, however, that many of these activities will require consideration and decisions by other specialists. It is the mark of a professional to possess the knowledge and skills needed to solve the problems of his profession. It is important also that he understand the limitations of his competences and professional responsibilities and that he exercise restraint in attempting to perform services requiring the professional assistance of other specialists.

It can be roughly assumed that any stipulation for the design and construction of physical education facilities which describes the manner in which the facilities are to be used and supervised should be formulated by the program specialist. Problems involving techniques of design and construction should be left for other professionals from other fields of endeavor to consider and to solve. In actual practice professionals from all fields of specialization benefit from the experience of meeting on common ground for the solution of perplexing problems, sharing experiences and discussing possible solutions, and evolving a plan which embodies the best thought representative of the professions involved.

The Educational Consultant -- The educational consultant is a planning specialist who possesses an extensive background of education and experience in educational administration, and who possesses an interest and experience in techniques and procedures of planning. While the educational consultant is of recent innovation, present activity to improve planning and construction efforts for educational facilities had emphasized the demand for this specialist. As a result, the educational consultant is used increasingly and is found on the staffs of progressive architectural firms; on the staffs of school building divisions of state departments of education; as members of groups connected with colleges and universities and offering full or part-time assistance in this area of knowledge.

As a rule, the employment of an outside consultant requires a financial outlay and consequently is not done as frequently as it should be. However, an efficient utilization of this specialist on a long-range and continuing basis would go a long way toward eliminating the emergencies which school boards and college authorities face with respect to shortages and inadequacies in school facilities; and such utilization should prove an efficient and economical measure in the long run.

The educational consultant should be expected:

1. To assist the administrator in devising an organization capable of assuring appropriate and continuous attention to problems of plant use, development, and expansion.

2. To recommend appropriate fact-finding studies, to indicate their nature and their methods, and to assist in their execution.

3. To analyze the facts uncovered and to report their significance.

4. To provide professional guidance as needed to assist all members of the institutional planning "team" in the efficient discharge of their respective duties.

5. To describe the type and number of educational facilities which will be needed in the foreseeable future.

6. To evaluate presently available educational facilities and to describe how they might be utilized best in the long-range educational program.

7. To assist in the development of the institutional master plan.

8. To develop and assist in the execution of a program designed to convince those in positions of authority (board of control, electorate) that the plan should be accepted and launched.

9. To assist the local administrator in devising effective procedures to be used in selecting an architectural firm.

10. To develop complete lists of program requirements (qualitative and quantitative) for all facilities needed.

11. To transpose these requirements to outline specifications and sketches for use by the architect.

12. To assist the architect by interpreting the prepared educational specifications.

13. To indicate when additional outside consultative assistance is needed to assure the completion of facilities which meet the requirements of the program, and to assist in locating the technical assistance needed.

14. To assist in planning for maximum utilization of the finished facility.

15. To help evaluate the finished facility.

Other Consultative Assistance

Other valuable sources of consultative assistance are available.

State Departments of Education -- Many state departments of education employ one or more full-time school building specialists for the purpose of assisting institutions within the state in solving their planning and construction problems.

In many states it is required by low that public-supported educational institutions submit to state authorities for final approval all plans and specifications for the construction of educational facilities. Whether legally required or not, however, it would seem

desirable to follow this practice in order to assure compliance with state statutes and regulations.

State Agricultural Experiment Stations -- The solution of many of the technical problems involved in planning outdoor field and court areas can be expedited with the assistance of the specialists employed at state agricultural experiment stations. Included on the staffs of these public organizations are agricultural engineers including agronomists. soil specialists, horticulturists, and specialists in irrigation, drainage, and forestry.

Other State Agencies -- State bureaus of buildings and grounds, state departments of public works, and state highway departments perform functions which are closely related to many of those performed by planning groups responsible for designing outdoor physical education facilities. Thses and other state agencies are constantly engaged in activities aimed at the solution of problems of design, construction, and maintenance. The specialists whom they employ often can provide valuable aid to educational plant development committees engaged in solving specific problems.

Colleges and Universities -- Plant development specialists frequently are members of the teaching and administrative staffs of colleges and universities. Useful ideas and practices may be learned from these individuals whose interests have led them to study extensively the problems confronted by groups planning educational facilities. These planning specialists include educational administrators, program specialists, technicians in the various aspects of the engineering profession, and maintenance personnel. Usually they are eager to lend assistance where it is needed, and such aid sometimes may fall within the scope of their official duties and be rendered without charge.

Private Industry -- With the boom in construction in all fields, there have arisen several types of private enterprise which provide services of one kind or another. One of the most useful of these is the private testing laboratory. Here it is possible to engage the services of research technicians for the purpose of testing various construction materials. Because of the experience represented in such an organization it is possible to obtain invaluable assistance in a variety of problems of a specific or general nature.

In addition, institutions contemplating construction programs are potential customers for materials and equipment. Manufacturers and distributors who supply these commodities recognize this market and are eager to assist in the solution of problems in the areas in which they are involved. Many of them conduct extensive research in specific areas and are among the best-informed within such limits. They may be equipped to furnish helpful data and usually make available to prospective customers the services of their laboratories and personnel. This is true of many of the manufacturers and distributors of floodlighting equipment, fences, grandstands and bleachers, drainage and irrigation materials, grass seed and fertilizers, various types of surfacing materials, apparatus, fixtures, and many others. Private industry can be a worthwhile and inexpensive source of information and should not be overlooked. It should be recognized, however, that commercial consultants are prejudiced in favor of the commodity they represent.

The Architect -- The competent architect is a professional who is qualified by education and experience to design and supervise the construction of buildings and facilities. Within the field of architecture there are several areas of specialization. Consequently, the modern architectural firm employs individuals representing a wide range of specialization including civil, mechanical, and electrical engineers.

Because of the wide range of specialization represented, the architect possesses vital knowledge required in the planning process. Many school systems and institutions of higher education retain the services of a competent architectural firm to assist in a continuing manner with the problems of institutional planning.

Among the specializations within the field of architecture, the landscape architect seems well equipped by education and experience to assist with the technical detail confronted in the design and construction of many of the outdoor physical education facilities. He is closely related in training and experience to the civil engineer, agricultural engineer, agronomist, soil specialist, horticulturist, botanist, and city and area planner.[1] Because his specialty is so closely related to the problems faced by those responsible for planning for outdoor physical education facilities, the functions which he is specifically qualified to perform are summarized below.

1. He begins with the detailed description of the program to be served as devised by the educational planner, and studies the problem preparatory to making suggestions as to ways in which the original idea may be improved.

2. He assists in site selection and evaluation.

3. He begins work with a topographic map of the site, studies it together with program specifications, and prepares a plan which is both artistically attractive and functionally efficient in its capacity to utilize the space to the best possible advantage at the least cost in human effort and capital outlay.

4. He provides for vehicular and pedestrian circulation.

5. He places buildings and other use areas in relation to topography and other influencing conditions.

6. He plans for drainage and irrigation of the site.

7. He devises methods of landscape construction and grading necessary to achieve permanently satisfactory results.

8. He plans and supervises planting, and arranges for the construction of walls, fences, and steps.

9. He prepares preliminary sketches and revises them into the final large scale drawings which guide and direct the construction of the facility.

10. He provides detailed information on the cost of work that is needed.

11. He prepares the specifications which are used by the prospective contractor in the determination of his bid.

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[1] Ann R. Taylor, "Landscape Architecture: A Summary Description," Landscape Architecture, October, 1945, p. 8.

12. He prepares a list of contractors whose reputation, ability, and financial responsibility he can endorse.

13. He assists in the preparation of the contracts.

14. He supervises the work and diligently guards the interest of his client against inferior work and unjust charges.

15. He authorizes payment in keeping with the terms of the contract.

16. He advises as to the best methods of maintenance.

The competent architect can perform many of the specialized architectural and engineering functions required in developing land for use in the physical education program. When skills which he does not possess are needed to deal with especially complex problems outside his field of specialization, he can assist in the selection of the appropriate specialist.

The Illuminating Engineer -- The success realized in lighting outdoor sports areas for night play calls for planning a system of lights for an increasing number of new facilities. Because of the nature of superior lighting plans, it is important that provisions for lighting be made early in the planning process. The problem of providing light adequate in intensity and quality for outdoor activities requires careful consideration of many technical details. Much of this information is supplied in the literature available in this expanding field. Some of it should be supplied by a competent illuminating engineer. Both the literature and the specialist are usually made available to institutions by various reputable firms specializing in the manufacture, sale, and installation of floodlighting equipment.

The Maintenance Specialist -- True cost depends on the first cost of construction and on the long-term cost of operation and maintenance. Early consideration of problems of maintenance is extremely important. The competent and experienced maintenance expert has vital information to contribute during the planning period. He is the individual best qualified to point out features of design and construction which will save in later costs of maintenance. This aspect of comprehensive planning is all too frequently neglected with the result that the completed facility is often difficult and costly to maintain.

The Student User -- In the final analysis, facilities for physical education are used mainly by the students of an institution. In most cases, students are not especially equipped to perform long-term planning functions, and perhaps they should not be included in a discussion of planning specialists. However, when students are not consulted during the initial stages of planning, the facilities which are designed and constructed frequently are not used to their maximum capacity. It would seem advisable, therefore, to include provisions for limited student representation on many planning committees. Through such representation a liaison can be established whereby both students and planners are informed of needs, desires, and plans. It is also highly probable that important contributions will result from this means of communication between the two groups. The manner in and extent to which students participate in the planning process will necessarily differ at each institution.

Plant Development Documents

Few, if any, individuals or groups are capable of operating efficiently without the aid of carefully prepared records and documents. While there is wide agreement as to the value of certain plant development documents, evidence is abundant to substantiate the belief that this important aspect of efficient administration is too frequently neglected. These documents show how the plant, program, and economic, social, and geographical area may be integrated most efficiently. When such documents are properly prepared, continually revised, and made readily available, they fulfil valuable functions. The area map, topographic and other surveyor's maps, building manual, master plan, and records of finance are among the more valuable and important of the plant development documents.

The Area Map -- An educational institution should be visualized as a community within a larger community. Plans for the development of the former must be closely interrelated with those for the latter. It is necessary, therefore, that officials for the larger community consider and incorporate the anticipated requirements of its educational institutions in its deliverative efforts. It is equally important that those who are charged with the specific responsibility of planning for the growth and development of educational institutions consider how such growth can be brought about in harmony with the growth and development of the larger community.

Every educational institution should have available for use at any time accurate maps of the area in which it is located. Such maps should be broad enough to provide geographical data of the entire area from which the institution draws the majority of its students, and should be detailed sufficiently to provide pertinent data relative to the contemplated economic development of the area and the use planned for unoccupied land. With respect to physical education facilities, such maps should show existing and proposed utility lines and transportation lines; the location of all parks, playgrounds, and recreation centers; possible population shifts and trends; and geological and geographical information on the physical properties of the surface and sub-surface soils.

Surveyor's Maps - - Accurate and detailed surveyor's maps should be prepared to show institutional property lines and those of adjacent properties, and to provide a picture of possible site utilization in general. They should show topographic detail by one-foot or two-foot contours, and should show locations of existing buildings and facilities, large trees and other natural objects, and utility service connections. Additional detail should be included to supply data needed for the solution of specific local problems.

The Building Manual -- A building manual is a document or a file which contains all of the best facts, ideas, and adaptations available to describe the facilities needed to carry out the programs of one's specialty. The building manual of any professional should contain ideas, adaptations, descriptions, photographs and sketches, suggested and widely accepted standards, books and other published materials, errors in design, and all other valuable reference information which proves so valuable when describing the functional features required in the facilities needed for a specialized program.

While each program specialist will exhibit individual preference in developing such a file, it would seem necessary for each to establish a minimum of three practices in order to acquire the sources of information required for competence in this area of specialization.

The first of these practices is the acquisition of a professional library containing publications which deal with problems of physical education facilities, equipment, and supplies.

Closely allied with the above suggestion, a second practice would require the development of a card catalogue containing bibliographical data on additional sources of general and specialized information in the areas of the design of educational facilities. Provisions should be made for filing such data under topical and author headings to simplify their use.

The third practice requires the development of a filing system into which ideas, photographs, sketches, and other published and unpublished descriptions of advanced ideas for the design of physical education facilities could be stored for ready reference.

Efficiency in one's work and professional habits is obtained through careful thought and considerable effort. Today there are a surprising number of useful ideas, records of activity and accomplishment, and sources of information and assistance which pass across the desk of the program administrator. Utilization of the practices suggested above will enable him to retain such data for the time when it becomes useful to him in his profession. Failure to establish these or similar practices results in below-par efforts and accomplishments when it becomes necessary for the professional to demonstrate competency in this specialized area of endeavor. His program and his students are the ultimate losers.

The Master Plan -- As soon as program requirements and ultimate plant needs become apparent, an institutional master plan should be developed to show how a proposed site is to be utilized. It is important to recognize that this document is based on long-term predictions, and it is subject at all times to modifications which become necessary as time reveals errors and inadequacies in the original plan. While it should be considered flexible, it also should be based on sound educational concepts at the outset, and every effort should be made to assure its authenticity and to avoid all possible errors and omissions. A departmental master plan should provide long-term estimates and detailed descriptions to show the steps contemplated in the efforts of the department to achieve its aim and accomplish its stated objectives.

Financial Statement -- A final recommended document has to do with long-term arrangements showing how the plant development program envisioned is to be financed. It is true that predictions as to the probable cost of construction are extremely difficult to make. If these costs are to be met as the need for them becomes necessary, however, they should be thoroughly considered well in advance of actual need. In addition, if an institution's public is expected to support the type of program its planners visualize, it should be provided with substantial evidence of the ability of those in charge of the fiscal affairs of the institution to handle funds discreetly. The financial statement should be developed to provide the same kind of flexible guidance as that suggested for the master plan. It should provide realistic data to show how the proposed plant development program is to be financed.

CHAPTER II

PLANNING OBJECTIVES

Social planning is prompted by the necessity for promoting the happiness and the total well-being of people. With respect to the plans devised to provide superior outdoor physical education facilities which promote the happiness and the total well-being of people, the objectives sought can be classified into three main categories: (1) those which promote efficiency, (2) those which protect the health and safety of people involved, and (3) those which promote beauty in the environment.

More specifically, outdoor physical education facilities:

1. Must provide for maximum utility

2. Must be valid

3. Must be sufficient as to kind in order to permit maximum promotion of all those activities which can be effectively and feasibly utilized to contribute to the goal of physical education and to the specific objectives described for a given program

4. Must be sufficient in number to permit peak load participation under actual conditions of use

5. Must be accessible to those for whom they are designed

6. Must be isolated from persistent and unnecessary distraction

7. Must be located strategically in relation to other facilities used in the program

8. Must combine qualities of permanence with those of flexibility in order to provide efficiency and to permit necessary alterations through the years

9. Must contribute to the economical operation of the educational program

10. Must permit ease of supervision and control

11. Must contribute to efficient maintenance

12. Must contribute continually and effectively to the good health and sanitation of the individuals who use them and to those who are affected by them

13. Must permit participation in the activities for which they were designed in the safest possible manner

14. Must be attractive and pleasing in appearance, and must contribute to the beauty of the environment

Efficiency Objectives

In fields of art and architecture, functionalism is recognized as a doctrine which considers the function to be performed as the primary consideration. Under this doctrine the artist or the architect is expected to modify the form and structure of a project in a manner necessary to provide a finished product which functions at the highest possible level of efficiency. Consideration of the requirements of other objectives, such as appearance, plays a secondary role.

In fields of educational planning, the lessons of the past are clear and unmistakable concerning the importance of designing educational facilities with the functional requirements of the specific program contemplated clearly in mind. Fortunately, effective methods have been and are being perfected to provide educational facilities which serve functional requirements efficiently, while embracing the features needed to satisfy other planning objectives at the same time.

A logical and important premise which should be adopted at the outset in any planning enterprise involving the functional design of educational facilities is the realization that ready-made or standard plans and specifications are non-existent. The design and construction of educational facilities is an immensely important undertaking which involves the expenditure of large sums of public money and the energy and aspirations of an indeterminate number of human beings. An educational program should be carefully formulated for the people of a specific locality. The facilities which are to serve such a program should be custom-made for that program, and for the people and the locality to be served by the program.

A community which employs a physical education professional has every right to expect a high level of leadership in all matters pertaining to the physical education program. Included is the leadership required to mold logical and intelligent long-range plans for the physical education program of the community plans which are based on the pertinent facts available at the local level together with sectional, regional, national, and world-wide trends in physical education which indicate what the program of the future will be like.[1]

Utility

Outdoor physical education facilities must provide for maximum utility. By definition, utility is used to denote a fitness for some desirable practical purpose. In order to contribute positively to this planning objective, each feature of an educational facility must be designed to satisfy some desirable practical specification. This planning objective points to the necessity for defining and clearly designating all functions to be served by such facilities. The fact that this stipulation is herein listed as the number one objective is significant. This objective should be satisfied early in the planning stage, and every aspect in the design of an educational facility should be evaluated with regard to its contribution to this objective. All too frequently, planning efforts have fallen short with respect to this

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[1]Harry A. Scott, Competitive Sports in Schools and Colleges, New York, Harper and Brothers, 1951, pp. 494-497.

requirement. Physical education facilities have been designed and developed on the basis of insufficient attention to all functional detail. As a result, some of the most important functional requirements have been inadequately considered and the finished facility fails to contribute to the degree required toward the attainment of program objectives.

It is an important responsibility of the physical education professional to describe in detail the uses to be served by a facility and to interpret this detail for other planning specialists.

Validity

Outdoor physical education facilities must be valid. This term as used in connection with educational facilities refers to the effectiveness of the facility as it serves the function for which it is primarily intended. As interpreted herein, this objective requires that a facility permit to the maximum the caliber of participation for which it is designed.

Physical education facilities which are designed for use in competitive programs must conform to the official rules which govern the activity as well as meeting those stipulations which are included in legal codes and ordinances. Ordinarily the same requirements are needed for facilities designed primarily for use in the instructional programs of physical education and physical recreation. Under certain circumstances a facility might be considered perfectly valid, even though it is smaller or larger or varies in some other respect from the requirements established by a national rules committee. This would be true only when such variance is specified to better accommodate a specific program.

By way of example, an official volleyball court is 60 feet by 30 feet and requires a 10 foot wide safety zone around the outside. In an area originally designed for competitive tennis with overall dimensions of 120' by 60', it would be possible to accommodate only one such official volleyball court. However, volleyball can be learned and vigorously enjoyed on a smaller court, and when competitive requirements are not the primary concern, other planning objectives may indicate the desirability of providing volleyball courts which are shorter and/or narrower. Thus, three volleyball courts 50' by 30' with 10' between courts and 5' around the outside could be provided in this same area and could accommodate a class of 36 persons.

This method for providing valuable opportunities for instruction and participation is present in other multiple-use areas where several activities are to be accommodated on a single surface, and where court areas which strictly conform to official rules would result in excessive and confusing lines. This is especially true with such activities as badminton and paddle tennis, for example, where the width for the doubles courts for both is the same but where the width for the singles courts is different and parallel lines six inches apart are required. Under certain conditions it would be a valid expedient to play both activities on a court which was in strict conformance with the official rules for only one of the activities.

While this objective usually refers to the functional features needed to assure efficient and enjoyable use, it serves an important purpose by emphasizing the need for evaluating the usefulness of a facility with respect to other objectives as well. The utility objective emphasizes the importance of describing in detail the functions to be accommodated by a facility. The validity objective points to the necessity for evaluating the degree to which the facility serves the functions for which it was designed.

Sufficiency As To Kind

The physical education administrator today is more fortunate in many respects than was his predecessor who is held responsible for the inadequacies which exist in the facilities constructed in his time. Among the assets of the present day professional is the fact that responsibility for proficiency in the realm of plant development has been accepted as a professional competency by individual members of the educational profession. As a result, a rich source of materials is being made available to assist in the solution of the perplexing problems confronted in the functional design of educational facilities.

The first National Facilities Conference and its published report[1] was followed by a second conference and a revised edition of this publication.[2] A report sponsored by the College Physical Education Association[3] recorded the thinking of representatives from the college program. Innumerable contributions have been made in this area through the efforts of many individuals and organizations including the National Recreation Association; state and community education, recreation, park, and planning departments; scholarly projects and publications by a rapidly increasing number of proficient contributors; courses of instruction at the undergraduate and graduate levels in colleges and universities preparing physical education professionals; and major efforts by professional designers and consultants. As a direct result of such efforts, considerable progress has been recorded during the past decade. Unfortunately, much of this progress is in the realm of generalized information, and there is need for more effort to provide objective data and to promote advanced but proven ideas.

A valuable outcome of this recent activity has been a criterion for the establishment of standards for the kinds of physical education facilities needed. This criterion states that facilities are required for all those activities which can be effectively and feasibly utilized to contribute to the aim of physical education and to the specific objectives described for a given program. Included are facilities for all aspects of the comprehensive program of physical education, including the program of instruction, programs of intramural and extramural sports, and programs of informal physical education.

Table I shows an extensive list of activities which can be included in the outdoor physical education program. While many are thought of predominantly as indoor activities, all lend themselves to outdoor participation under certain conditions.

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[1]National Facilities Conference, A Guide for Planning Facilities for Athletics, Recreation, Physical and Health Education, Chicago, The Athletic Institute, 1947.

[2]National Facilities Conference, Planning Facilities for Health, Physical Education, and Recreation, Chicago, The Athletic Institute, 1956.

[3]Karl Bookwalter (Editor), College Facilities for Physical Education, Health Education, and Recreation: Standards for Design and Construction, College Physical Education Association, 1947.

TABLE I

OUTDOOR PHYSICAL EDUCATION ACTIVITIES

Archery
Badminton
Baseball
Basketball
Bowling
Camping
Casting
  Bait
  Fly
Dancing
Fishing
Fencing
Field Hockey
Flickerball
Football
Golf
Gymnastics
Handball
Horseshoes
Ice Hockey
Ice Skating
Lacrosse
Marksmanship
Roller Skating
Shuffleboard
Skiing
Soccer
Softball
Speedball
Swimming
Tennis
  Aerial
  Deck-Floor
  Lawn
  Loop
  Paddle
  Table
  Tether
Track and Field
Volleyball
Weight Training
Wrestling

The objective pertaining to the kinds of facilities provided extends also to the functional features incorporated into each activity area designated for the educational program. The responsibility of the program specialist is again emphasized with respect to this objective. He must provide advanced leadership in planning the program and in describing in minute detail the specific functions to be served by each and every facility unit needed for that program.

Such detail should include: (1) dimensions for surface areas including space required for the field or court area as well as the additional space required to provide maximum utility and safety for participants and spectators; (2) a description of the qualities necessary to provide the desired surface for the activity; (3) specifications for the orientation of the facility with respect to the sun and prevailing winds; and (4) a description of the fixtures and permanent equipment needed to promote and enhance the activity including goal and net supports, backstops and fences, water and electric power, functional requirements in landscaping, and others.

Those general and specific features which contribute to the everyday usefulness and desirability of outdoor physical education facilities are discussed at length in subsequent chapters.

Sufficiency As To Number

Functional adequacy requires sufficiency in quantity as well as quality. It is obviously important to designate the kinds of activities to be included in a program and the functional features needed to serve those activities. It is equally important to consider all available factors which indicate the number of facility units needed for each activity. A practical standard can be stated as follows: outdoor physical education facilities must be sufficient in number to permit peak load participation under actual conditions of use.

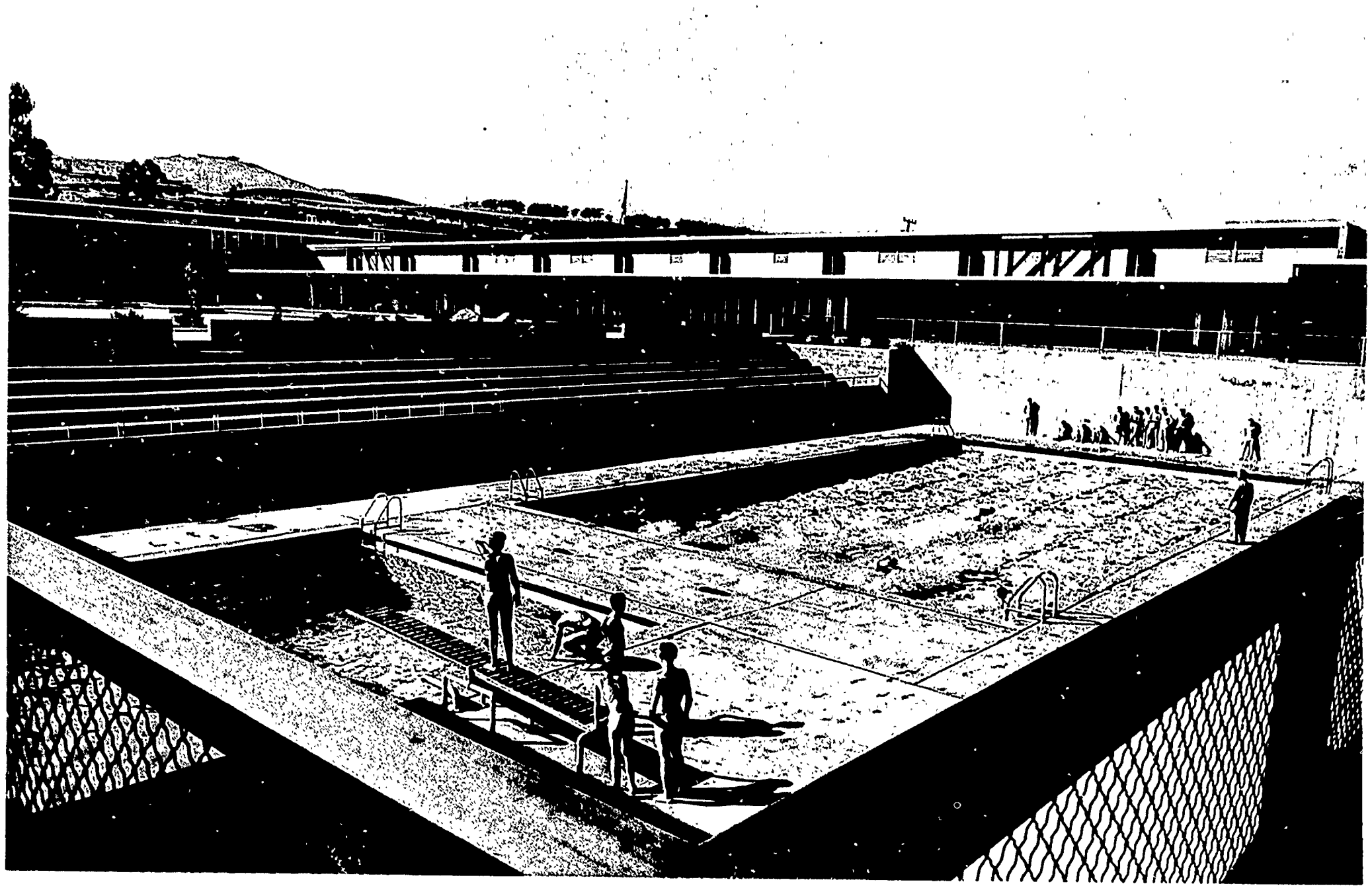

PLATE 1. SWIMMING IS UNSURPASSED IN THE GREAT OUT-OF-DOORS. Hillsdale High School, San Mateo, California. Courtesy of San Mateo Union High School District.

In our democratic society it is desirable that local initiative and ingenuity be encouraged. The physical education program of a community should be developed to accommodate the needs and stimulate the interests of the specific people who are to be served by that program. It is undesirable and unrealistic, therefore, to attempt to devise a formula or to propose a standard for use in determining the number of facility units needed for physical education programs generally. Too many variables are present, and in determining standards of quantitative sufficiency for any community the facts which should be utilized must be determined and studied in light of all the pertinent information available locally.

In order to make realistic estimates of future peak load participation for each activity included in the program envisioned for a community, it is necessary to study the facts which influence participation. Among these the following matters are significant.

1. The maximum number of students for which facilities are being provided.

2. Curricular requirements for physical education, including the number of years required, number of periods required each week, length of each period, maximum and desired size of each class, activities to be included, and plans for co-educational physical education.

3. Emphasis on the voluntary program, such as formal electives, intramural and extramural athletics, and other recreational activities.

4. The nature of additional long-term institutional policies which influence the degree of success to be logically anticipated in the various aspects of the physical education program.

5. The availability of acceptable facilities belonging to other organizations and the nature of existing and contemplated policies and prospects for the joint-use of such facilities.

When the precise description of the program to be sponsored has been determined and a comprehensive appraisal of potential participation has been completed, it is a matter of simple arithmetic (together with a high degree of foresight and understanding of program problems and possibilities) to decide the actual number of facility units required for the program. At this stage in the planning process it is well to remember that considerable accuracy is anticipated in determining immediate program requirements. At the same time it is important to realize that long-range estimates are subject to innumerable and unpredictable changes. Such estimates should definitely err on the side of too many and too soon rather than too little and too late.

In this respect it is well to anticipate that the rapidity of recent advancements in this world point to the probability of a life of plenty and one of increasing leisure for an increasing number of the earth's inhabitants. It is important, therefore, that the goals we establish for our programs be optimistic ones. It is also important that we reserve large and desirable tracts of land for the enjoyment of the human beings who do or who will live in the communities of the world.

Our federal government, through its forest service, park program, and various conservation efforts, has initiated what to its present citizens seems like a generous and farsighted program. In light of the life we know today and that which our ancestors enjoyed, these policies and measures do seem adequate. Only time will tell how they will be evaluated by the citizens of the future.

Those who plan educational facilities should raise their sights, and this is especially true with respect to the facilities which man will utilize in his leisure time if they are available. All men must be impressed with the realization that facilities for physical education and recreation are becoming increasingly important. Such facilities contribute to the enjoyable and dignified life of modern man, and they add immeasurably to the economic assets of the community. It is important that educational professionals adopt and promote this philosophy in their thinking and in the recommendations which they record. Members of these professions should not be satisfied with conditions represented by the status quo. It is important to plan BIG to promote the happiness and total well-being of people.

Table 2 indicates the actual number of participants accommodated by each facility unit concerned under actual game conditions for a representative list of physical education activities.

TABLE 2

NUMBER OF PARTICIPANTS ACCOMMODATED PER FACILITY UNIT

Activity	Number Accommodated	Activity	Number Accommodated
Archery	4	Horseshoes	4
Badminton	4	Ice Hockey	12
Baseball	18	Lacrosse	24
Basketball	10	Marksmanship	4
Casting	20	Shuffleboard	4
Fencing	2	Soccer	22
Field Hockey	22	Softball	18
Football	22	Speedball	22
Flickerball	14	Tennis	4
Handball	4	Volleyball	12

When determining the actual number of separate units needed for a specific program there are two administrative principles governing use which should be considered. These concern provisions for multiple-use and for joint-use of facilities.

Multiple-Use -- Multiple-use refers to the utilization of a single area in the promotion of two or more activities. Planning for the multiple-use of a facility requires adaptation of space based on a functional understanding of physical education activities combined with a certain amount of inventive talent.

Obviously some physical education facilities are designed principally to serve a single activity in the program. This is especially true of facilities for the spectator sports and others utilized extensively in the extramural sports program. The football, tennis, and basketball stadia, and the varsity field in general are examples of this kind of facility. Many institutions and communities will feel justified and financially capable of maintaining these highly specialized areas, and this is naturally a decision to be made locally in each instance.

However, many facilities utilized in the physical education program can be used in the promotion of more than one activity. This is especially true of the field activity areas which are used to promote one kind of activity during one season of the year and others during other seasons. There are numerous possibilities for doubling up on physical education facilities, and in most instances such possibilities should be exploited because of the economies involved and the opportunities which wise application of the multiple-use principle provides for enriching the program.

A single example will point out some interesting possibilities afforded by such planned flexibility of use. A doubles tennis court requires a surface area 120' by 60'. This area will accommodate 4 players in tennis under acceptable conditions of use. If this facility is provided with a hard, all-weather surface, if removable net posts are adopted, if a solid wall is provided along one side, and if a curb is constructed around the outside, this area can be used for many other activities as well as tennis, as shown in Table 3.

Other possibilities of this nature are numerous and should be considered throughout all stages of planning, including evaluation of the site, arrangement and marking of field and court areas, surfacing, location and design of fixtures for net and goal supports, provisions for sportslighting, and the location, design, and type of seating arrangements for spectators.

Joint-Use -- Joint-use refers to the utilization of a specific facility unit for the promotion of the programs of two or more administrative organizations. An example of the joint-use of a facility is seen in the common practice whereby a park department owns and maintains the facility, but it is used by public and private educational institutions, by the community recreation department, and by numerous private, public, and voluntary agencies.

It is doubtful if many except the very large or most wealthy administrative organizations can justify the private ownership of the wide variety of facilities each requires for the diversified sports program it desires to provide. In many instances, it is a necessary and desirable practice for the institution of higher education, the public school system, the local recreation and park department, and related organizations to combine their resources and to plan facilities which will meet requirements for all programs.

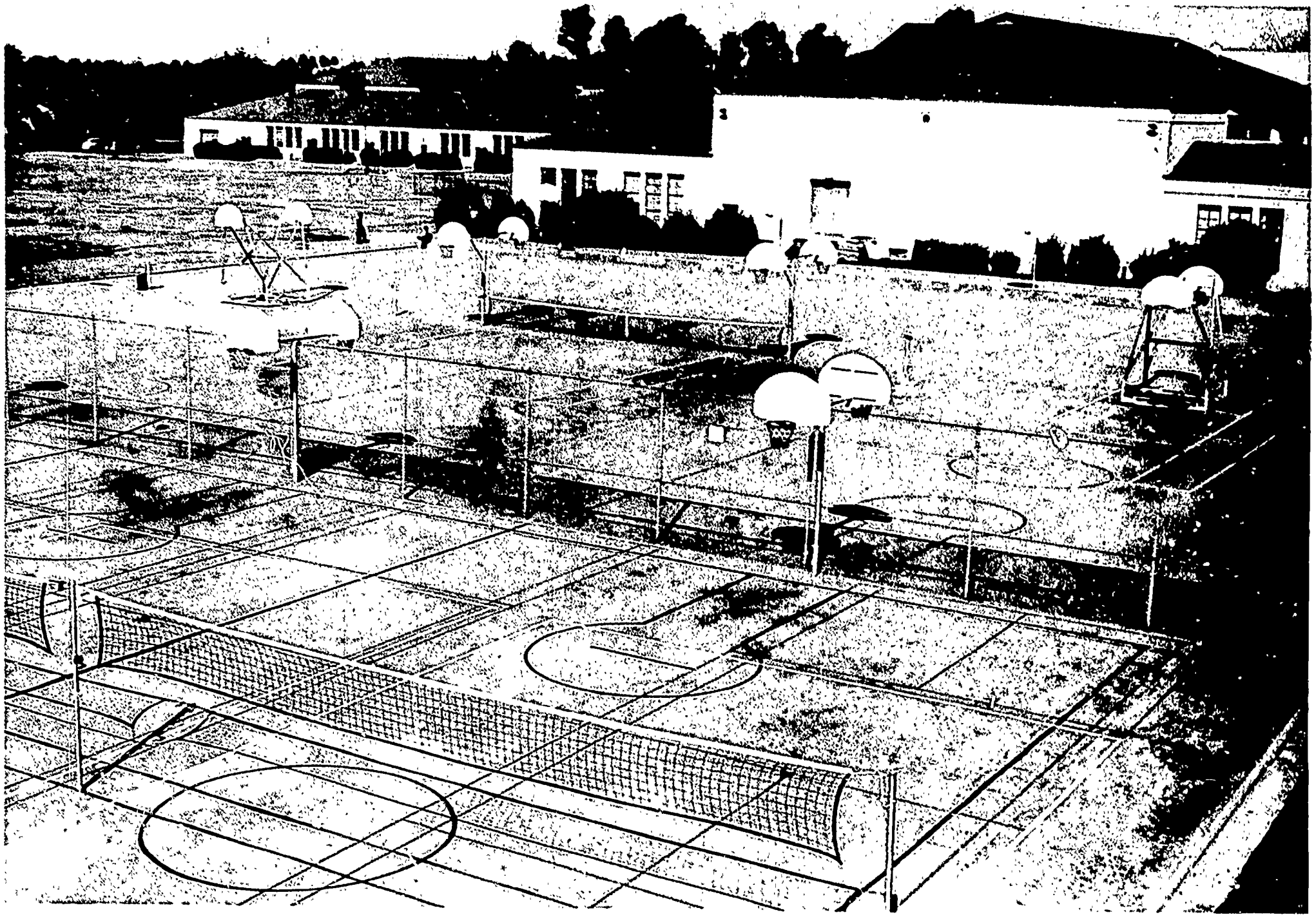

PLATE 2. MULTIPLE-USE SPORTS AREA. This area measuring 241 feet by 179 feet has a cement concrete surface. The area in the background accommodates 8 basketball or 3 tennis courts, while area in foreground provides space for 14 badminton, or 4 basketball, or 5 volleyball courts. Courtesy of Catherine A. Wilkinson, North Phoenix High School, Arizona.

TABLE 3

A DOUBLES TENNIS COURT SERVING AS A MULTIPLE-USE AREA

Facility Units	Activity	Participants Accommodated
1	Tennis	4
4	Badminton	16
1	Volleyball (Regulation)	12
3	Volleyball (50' by 30')	36
4	Paddle Tennis	16
1	Roller Skating	35
1	Ice Skating	25
3	Handball	12
1	Basketball (Regulation)	10
6	Basketball ("Backyard")	36

Kretchmar[1], in studying ways by which colleges can provide the facilities needed for the types of programs desired, found that off-campus facilities are utilized for golf, riding, ice skating, sailing, skiing, tobogganing, hiking, tennis, bowling, and camping. Other evidence adds emphasis to the conclusion that in actual practice, joint-use of educational facilities is becoming increasingly widespread. It is difficult to justify part-time use of expensive educational facilities, and when adequate administrative procedures are adopted, all parties concerned benefit from a sharing of available resources.

When plans for joint-use seem desirable, it is important to clearly establish the lines of control, maintenance, and utilization for each such facility provided. Predetermined agreement with respect to legal, monetary, and administrative powers and responsibilities should be understood and acceptable to all parties concerned.

Location

The location of physical education facilities in relation to each other and to the people who will use them is important in evaluating their total long-term usefulness in the program for which they were designed. These facilities should be accessible to those who are to use them; they should be effectively isolated from the conditions which detract from their total usefulness; and they should be carefully integrated one with the other.

[1]Robert T. Kretchmar, "The Development of Co-Education in College Physical Education" (Unpublished Ed. D. project, Teachers College, Columbia University, New York, 1949), p. 99.

Accessibility -- Physical education facilities should be accessible to those individuals who will be the principal users. In the case of educational institutions, the students for whom they are provided should receive first consideration. It is important, therefore, that these facilities be located conveniently in relation to the other facilities which students use such as dressing and shower facilities, dormitories, classrooms, shops and laboratories, and the like.

It is important too, that the accessibility objective apply to those who will be teaching activities and in general supervising the facilities in question. Where spectators are to be encouraged, special thought is required to assure their entrance and exit easily and efficiently and without unnecessary complication.

The attainment of this objective will be limited by the availability of suitable space and by the amount of competition encountered for the use of such space for other purposes. It will also be dependent on a clear understanding of all functional requirements for the program envisioned and the development of a comprehensive statement describing these requirements.

Isolation -- Outdoor physical education facilities must be isolated from persistent and unnecessary distractions. They should be located in attractive areas where there is an absence of excessive smoke, dust, and unpleasant odors; they should be isolated from busy streets where traffic is a hazard and a nuisance; there should be a freedom from such restrictions and hazards as those encountered in hospital or fire station areas; they should be arranged to eliminate or minimize interruptions which occur when there is travel through them during periods of use; and, provisions should be made to permit their use for the optimum good and enjoyment of those who use them, including the opportunity for participants and spectators alike to be spontaneously noisy.

Integration -- Outdoor physical education facilities must be lo ated strategically in relation to one another and to other accommodating facilities utilized in the physical education program. Athletic fields and court areas should be readily accessible to dressing and shower facilities. Wherever possible, this is accomplished by locating outdoor play areas near the gymnasium, stadium, or fieldhouse where lockers, showers, first aid, and other necessary service facilities are already in existence. When such facilities are not readily available, plans should be formulated to provide them. The facilities comprising a physical education plant should be located in close proximity, one with the other, as an economical means whereby they can be used, supervised, and maintained efficiently.

Adaptability

Outdoor physical education facilities must combine qualities of permanence with those of flexibility in order to provide efficiency and to permit necessary alterations. Facilities which are to remain functionally useful over a long period of time should be designed in such a way as to permit ease and economy in bringing about the alterations and the changes which may be required throughout the years.

Expansibility -- If educators in the field of physical education and recreation act intelligently and energetically to achieve the objectives formulated for these educational programs, participation in physical education activities should increase tremendously in the decades ahead. Because it is difficult to formulate accurate long-range estimates of the number of facilities which will be required, it is necessary to reserve space

considerably in excess of that apparently needed for present programs. The dilemma faced by a majority of urban institutions today is the result of an inability and a failure to plan adequately for future expansion. Extravagant amounts of space, as judged by present-day standards, should be set aside for the programs of the future. The accomplishment of this objective requires courageous and aggressive leadership. It is difficult to persuade the public to contract to finance the programs of future eras. Unless leadership effectively convinces its publics of the soundness of such long-term economy, it cannot be done.

Flexibility -- Plans for efficient long-term use should also anticipate the possibility of changes in emphasis in the program through the years. In order to plan for such unpredictable eventualities, it is necessary to locate field and court areas on sites which are somewhat larger than minimum requirements demand; that goal and net posts, backstops and other fixtures, and construction features be planned in such a way as to permit ease of rearrangement if and when it becomes necessary to do so; and to utilize to the effective maximum all opportunities for multiple-use of all facilities.

Economy

Errors and omissions at the planning stage involve more than increased first costs and are paid for throughout the life of a facility in increased costs of maintenance and use, and decreased results in the attainment of program objectives. Most inadequacies can be eliminated at the planning stages by individuals who have had experience in designing, using, and maintaining physical education facilities. Economical design will assure the most efficient utilization of a site; it will include features needed to permit efficiency in use, supervision, control, and maintenance; and it will result in the wise selection of materials and construction methods in developing the physical plant. By careful and enlightened planning, it is possible also to preserve the natural features of a site which add so greatly to the eventual appearance of the development.

It is obviously important that educators practice principles of true economy in the design of educational facilities. In this respect, the word economical and the word efficient should be considered synonomously to describe a state of being whereby the greatest return over a long-range period of usefulness is realized at the least possible cost in human effort. From this standpoint, first costs are measured in dollars AND in energy expended in developing the facilities required for educational programs; and long-range costs are measured by the amount of money AND energy required to promote successfully the program desired. True economy in this instance results only when educational facilities are provided which make it easy to promote outstanding educational programs. Such facilities are attractive and they encourage outstanding participation and teaching; they eliminate or decrease to the absolute minimum the causes of frustration and unnecessary wear and tear on users, program administrators, and maintenance personnel; and they guarantee to those who pay for them an absolute maximum return on the dollar expended in terms of human enjoyment and progress.

From the standpoint of true economy and efficiency in the design and construction of educational facilities, therefore, a major effort at the initial stages of planning, designing, and construction will pay off in real long-range economies. When important considerations are ignored or violated at the planning stages and serious errors and omissions are permitted, the efficient and economical operation of the finished product is jeopardized. There is widespread usage of the saying "it costs only a little more to go

first class", but there is abundant evidence to emphasize that where educational facilities and programs are concerned, first class is the only way to go.

A single example will serve to emphasize this simple point. The problem of properly grading an outdoor sports area frequently requires a major effort and a large capital outlay. If this job is to be accomplished properly, it is necessary that the services of a competent engineer be obtained to conduct a careful topographic survey. This survey must then be accurately interpreted to determine the most efficient manner to bring about the desired grade. Next, a dependable earthmoving contractor is needed. Each of these tasks almost always requires a capital outlay which is quite significant for most educational budgets. Nevertheless, each step is important insofar as true long-range economy is concerned. All too frequently, one or more of these steps is slighted with a significant resulting loss in long range results.

Safety and Health

Facilities provided by any educational institution or social agency for the purpose of contributing to the happiness and well-being of people should be safe and healthful in themselves, and they should contribute to the development of desirable attitudes and ideals toward health and safety in those who use them. Physical education has long accepted health as a major objective, and a well-conceived program of physical education must strive to promote the health of the individual and the community.

In addition to the moral and professional responsibility to provide a healthful and safe environment, educational institutions must recognize the legal responsibilities which are involved. While there is some degree of legal immunity for accidents for public education institutions, there is also considerable doubt concerning the effectiveness of such immunity in instances of negligence.[1] From the standpoint of legal responsibility, therefore, safe and healthful facilities must be considered a necessity.

Whether the responsibility is of a moral or legal nature, however, the conscientious educator desires to protect the welfare of those who come into contact with his institution. Where problems of program or facilities are concerned, he is eager to eliminate all hazards. When planning facilities, the early consideration of health and safety is a necessity. A mistake in the original site selection, or in any aspect of design or construction which results in a safety or health hazard is difficult, costly, and sometimes impossible to correct at a later date.

Safety -- Planning for safety in the physical education program is essential. Important aspects of the total safety program can be incorporated into the original design of the facilities to be used in the physical education program. If this important responsibility is to be discharged efficiently, it is necessary that at least one person responsible for such planning be widely informed as to the safety implications of the activities to be promoted on the facilities being designed. This individual would be expected:

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[1]W. Stewart McCready, "Insurance is a Safeguard for College Finance," College and University Business, February, 1950, p. 8.

1. "To keep informed about and to introduce as rapidly as possible the best safety practices in the physical education field when applicable to his situation.

2. To keep informed about and to recommend the best safety equipment in the physical education field.

3. To inspect the physical education plant according to a definite time-and-item schedule. (Some areas need to be inspected daily, and annual inspection may suffice for others).

4. To guide and encourage all others connected with the physical education program....to set up suitable safety objectives.

5. To keep complete accident records and report these to the central office.

6. To use accident records in planning the curriculum and in correcting errors in environment and equipment.

7. To be ready and able to plan safe play areas within limits of available resources--money, space, equipment, etc."[1]

From the above statement it is apparent that planning for safety in physical education is a continuous and specific responsibility of the physical education professional.

Among the considerations with respect to built-in safety in physical education facilities, the following are important:

1. The site should be so located as to avoid the necessity for participants or visitors to cross roads or other dangerous transportation lanes in arriving at any particular activity area. Where this ideal is not possible, underpasses or overpasses should be constructed to allow safe passage across such lanes of traffic.

2. The site should be large enough to allow for a sufficient number of teaching stations and facility units to permit their safe use during periods of maximum participation and under actual conditions of use.

3. The site should be large enough to avoid the necessity for crowding or overlapping facility units. A safety zone of sufficient width should be included to separate units effectively.

4. All use areas should be graded carefully so as to assure quick and efficient drainage, thus eliminating hazardous, unhealthful wet spots after rains.

5. The entire area should be free of dangerous obstructions and hazards including uneven spots, stones and broken glass, trees and poles, and shaded areas which may result in an undesirable shadow over a critical use area.

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[1]National Safety Council, Safety in Physical Education and Recreation for Elementary and Secondary Schools, Chicago, National Safety Council, Inc., 1941, pp. 10-11.

6. The surfaces of all play areas should be such as to reduce the frequency and seriousness of injuries sustained from falls.

7. Fields, courts, and other use areas should be clearly marked at all times to add to the validity of the facility, reduce possible hazards, and provide guide lines for participants and non-participants alike.

8. All goal posts and other possibly dangerous and unremovable obstructions should be padded to a height of six feet to aid in reducing the seriousness of unavoidable accidents caused by their presence.

9. Jumping pits and other special areas of this nature should be isolated from other use areas, or provisions for covering or removing them should be made to assure their elimination as possible hazards. They should also be large enough, resilient enough, and of proper construction to protect those who use them.

10. All facilities should be constructed in accordance with state building codes, local ordinances, and recommendations of national, private, and professional agencies relative to fire, panic, and other hazards.

11. All facility units should be constructed and located to assure ease and efficiency of supervision.

12. The use of a standardized color safety code in play areas and on physical education equipment is an effective method of warning patrons of the obvious ans subtle dangers which are present in these areas.

Health -- Physical education facilities must be designed in such a manner as to contribute to the improved health of those individuals who use them, and they should serve to further health objectives in the total environment in which they are located.

The benefits of exercise in the fresh air and sunshine have long been recognized. Because of this, it is desirable to use the out-of-doors in the physical education program in every way feasible. The facilities utilized in the outdoor physical education program must be designed and maintained to contribute to health objectives in an optimum manner. They must incorporate features which safeguard the health of those who use them; they must positively represent desirable health features; and they must exclude all unhealthful conditions. Among the many considerations which are important to health objectives are the following:

1. The general location of the site of the proposed development should be such as to lend assurance that a healthful environment will prevail.

2. There should be optimum long-term assurance of the absence of conditions in the immediate neighborhood which result in air pollution, excessive noise, and confusion such as that which prevails in harbor areas, rail and air terminals, and on automotive thru-ways.

3. Some means of protection should be apparent from unhealthful conditions caused by dirt, dust, and the like which would be carried into the area by prevailing winds.

4. All activity areas should be graded and improved in such a way as to eliminate conditions detrimental to health, such as standing water.

5. Surfaces should be developed which eliminate the prevalence of excessive dust in activity areas.

6. Emergency facilities for first aid should be readily accessible to safeguard the health of participants and spectators injured in physical education areas.

Appearance

Outdoor physical education facilities should be attractive and pleasing in appearance and should effectively contribute to the beauty of the surrounding environment. While this objective is usually subjected to consideration only after functional and protective objectives have been discussed, nevertheless it is fortunate that there is a widespread and aggressive effort in planning ventures to place proper emphasis on beauty and appearance. It is also fortunate that almost any functionally attractive outdoor physical education facility does contribute to the appearance of a place. When plans for imaginative landscape design in physical education areas are included, increased beauty of the environment is almost certainly assured.

Well-planned outdoor physical education facilities can be attractive additions to any campus or community, and numerous possibilities are present to assure their efficiency and attractiveness at the same time. Needless to say, in a civilization in which so many efforts of man seem destined to detract from the natural beauty of the world, any and all opportunities which exist to reverse this tendency should be exploited. In the design of outdoor physical education facilities there are innumerable opportunities to preserve and improve the natural beauty which exists in the environment. Effective efforts in this direction are necessary for the enrichment of human living.

PLATE 3. A BEAUTIFUL SETTING FOR PHYSICAL EDUCATION. A scene from the New Mexico Institute of Mining and Technology golf course which was carved out of desert land.

CHAPTER III

SITE SELECTION

Fortunate is the administrator faced with the responsibility of planning and constructing an entirely new educational plant. He has the opportunity to utilize the total accumulation of pertinent knowledge available; to profit by (and avoid) the mistakes of the past, and to design and place into use facilities which are quantitatively sufficient, efficient, economical, functional, and aesthetically attractive. The decision relative to the selection of site on which to house this new and modern educational plant is certain to have both an immediate and a far-reaching impact on the success or failure of his efforts. Basic principles utilized in connection with the original selection of the site are useful also in evaluating the fitness of a group of facilities previously developed.

The following is a useful list of basic considerations to be observed in site selection and evaluation.

1. As a general rule, a single large site which will accommodate all aspects of a program will prove more desirable and efficient than several separate smaller sites which provide identical accommodations.

2. The only logical standard for judging the desirability of a site from the standpoint of size and shape must be determined by evaluating its adequacy to provide generous ground areas for the number and kinds of facilities needed.

3. The gross topography of a potential site is of immediate importance in evaluating its possibilities for serving the program.

4. The location and environment of a site are important considerations in judging its suitability.

5. The nature of the soil and sub-soil found at a site is important from the standpoints of usefulness and ultimate true cost of development and operation.

6. The availability of essential utility services and the cost of providing them must be considered.

7. Ultimate true costs include more than just the original purchase price of a site; all cost factors related to purchase, development, and long-term operation must be considered.

Size and Shape

Planning for outdoor physical education facilities should be based on recognition of the need for an increasing amount of space. This is necessary to provide for present program requirements and to meet the future interests and needs of those who will be served by the program over a long-term period. In contemplating the possibility and

PLATE 4. MASSIVE TARGET HILL ATHLETIC FIELD, U.S. MILITARY ACADEMY. An area such as this which will accommodate six soccer games simultaneously provides maximum assurance of long-term usefulness. Courtesy of Public Information Office, U.S. Military Academy, West Point, New York.

the probability of error in long-term estimate, it is better by far to err in favor of too much space than of too little.

In considering this matter, the National Council on Schoolhouse Construction suggests that

> ...the needs for land should be measured in terms of the probable functional requirements of the site. Each case should be studied by the development of actual site layouts to include areas for unorganized play for various age groups, organized games with playfields conforming to strict specifications and with enough fields for each sport to meet the needs of both boys and girls. Such needs should be determined in terms of the maximum number of groups or squads, practice fields, parking for pupils, staff, visitors, and spectators at games, spectator space, lawns, drives, walks, the building and its future additions plus from 20 per cent to 30 per cent of additional usable area for unforeseen needs of the future. The Council believes that in order to meet these needs, it would be highly desirable to increase the suggested minimum formulas for site size by a substantial margin.[1]

These recommendations are widely accepted but also are frequently disregarded in actual practice. The data needed to determine actual space requirements are found in the books of official rules which govern physical education activities and in the recommendations of program specialists. A realistic estimate of the total amount of space needed for a specific program can be formulated from these combined sources. A summary of these data follows.

Archery -- The target archery range requires an unobstructed space 135 yards long in order to include all standard competitive shooting distances, to provide a clear space of 25 yards behind the targets, and to make available 10 yards in front of the 100-yard shooting line for archers and non-shooters. Targets should be placed not less than 12 feet apart, but a distance of 15 to 18 feet is recommended. Ten additional feet of space should be reserved on each side of the target area.

Space required for the field archery range may vary according to the terrain and the arrangement of the targets. An official range which serves the total objectives of this fine sport can be developed in areas not especially suited for other physical education activities. For official sanction, such a range requires the approval of the State Representative of the National Field Archery Association.

Badminton - - A singles badminton court is 44 feet long by 17 feet wide. The doubles court has the same length but is 20 feet wide. Because of the nature of this activity, a safety zone 6 to 8 feet in width completely around the court is all that is needed.

Baseball -- An unobstructed area with a minimum radius of 250 feet from home plate and extending between the foul lines is required in collegiate and organized baseball. Outside the foul lines, and between home plate and the backstop, there should

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[1] National Council on Schoolhouse Construction, Guide for Planning School Plants, Nashville, The Council, 1949, p. 20.

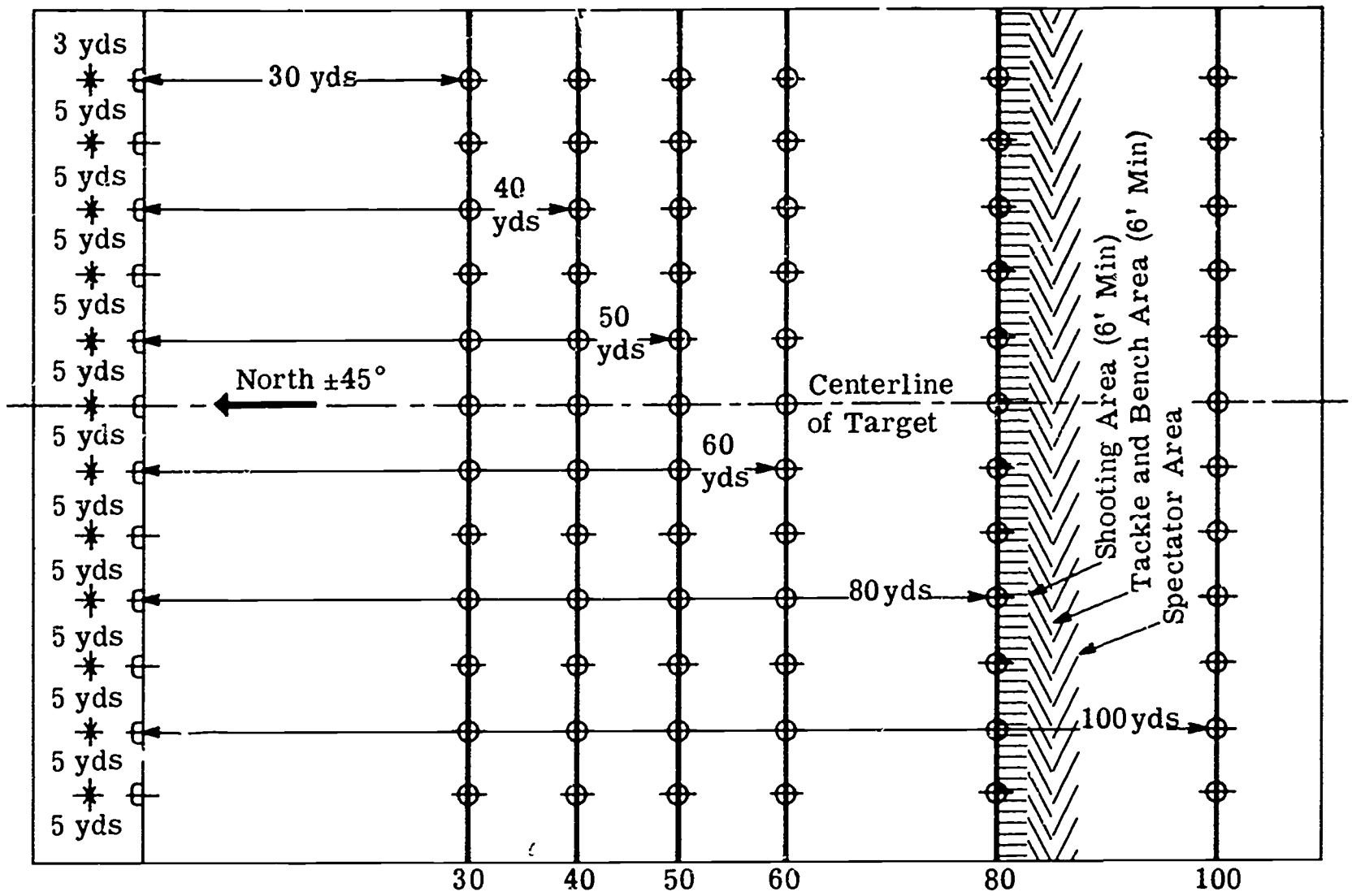

Figure 1. Layout of Archery Target Range.

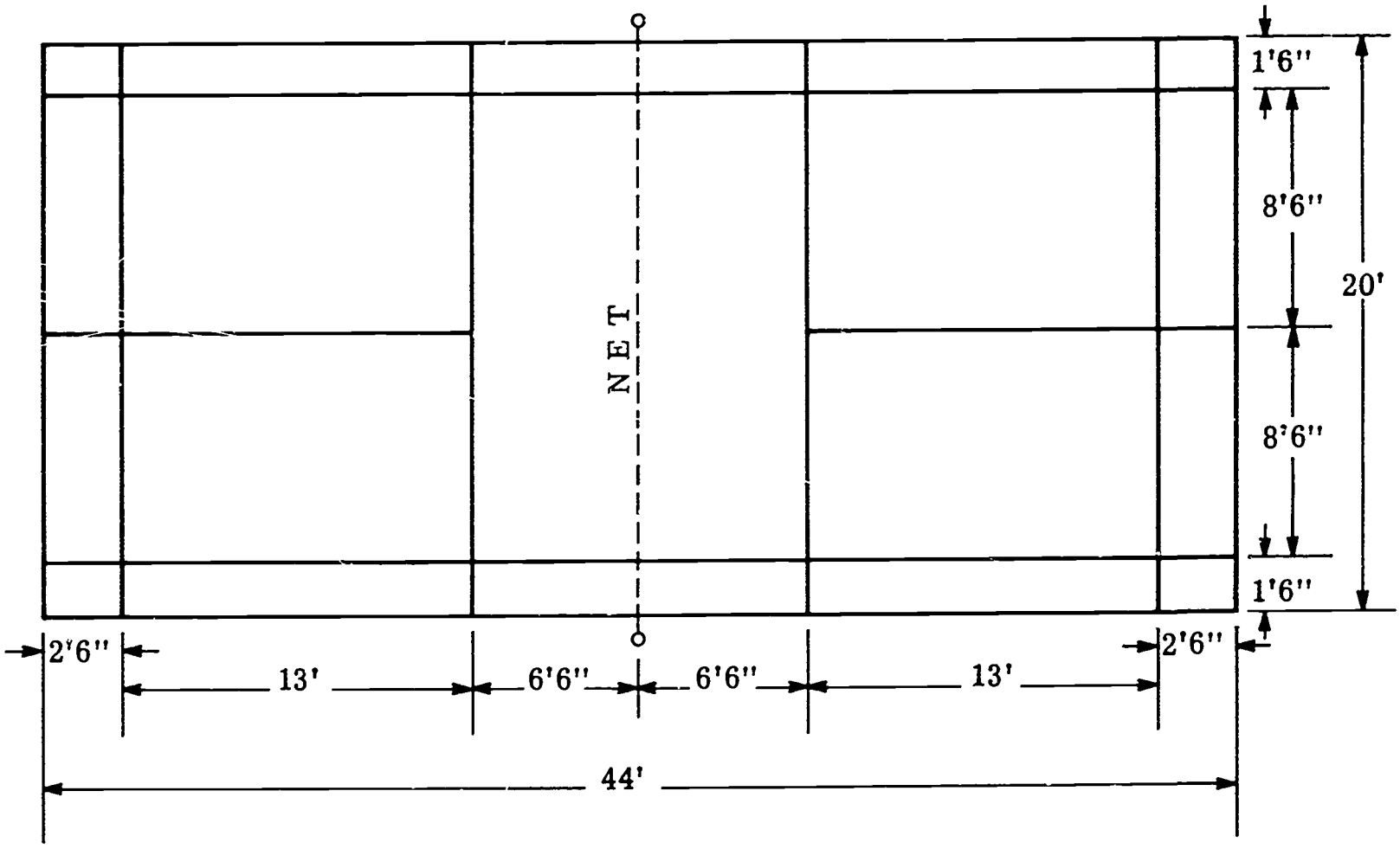

Figure 2. Layout of Doubles Badminton Court.

be an unobstructed area of not less than 60 feet in width. A distance of 320 feet or more along the foul lines, and 400 feet or more to center field is recommended. A level space 350 feet by 350 feet will accommodate a single baseball field, but a larger 425 by 410 feet is recommended; and where two or more fields are arranged in such a way that the right field of one adjoins the left field of the other, the distance between home plates should be at least 550 feet.

A study of the various boys' league rules discloses substantial variations with respect to required and recommended space requirements. Little League rules recommend a distance of 175 feet between home plate and the outfield fence along the foul lines, with 180 feet in center field, and 20 feet behind home plate and outside foul lines. Babe Ruth League recommendations call for 285 feet at each foul line to a maximum of 303 feet in dead center field. Pony League Rules stipulate 40 instead of 20 feet of space behind home pl te and outside foul lines.

Basketball -- Recommended dimensions for the college basketball court are 94 feet by 50 feet, and for high school, 84 feet by 50 feet. For junior high school age basketball, the court is reduced to 74 feet by 42 feet, and for Biddy Basketball, the recommended court size is 60 feet by 40 feet. Ten foot safety zones around the court perimeter are desirable.

Bowling -- Lawn bowling requires a perfectly level turf area 110 feet long by 14 feet wide. Ordinarily a lawn bowling area is constructed in an area 120 feet square in order to permit bowling in both directions and thus ease the maintenance problem with respect to worn grass.

Outdoor bowling alleys (10-Pin) have been constructed and used with considerable success in many localities. The overall dimensions are essentially the same as for the indoor game; namely, 83 feet feet by 6 feet 2 1/2 inches wide for one alley, 11 feet 5 1/4 inches wide for two alleys, and 22 feet 7 3/4 inches wide for four alleys. In addition, a minimum distance of 11 feet should be provided behind the pits and 8 to 20 feet in front of the bowling-bed approach.

Camping and Outdoor Activities -- There is no absolute standard which can be utilized in determining the size of areas needed for camping and outdoor activities. While extremely worthwhile experiences in these activities can be provided in areas which are quite small, the size and nature of the facilities available are definitely limiting factors. Because of the proven desirability of these activities, and because of the desirability of preserving and improving our natural environment, generous standards should be adopted.

Casting -- While bait and fly casting are usually associated with fishing, these activities are enjoyed in many localities far removed from large bodies of water. Where water is available, a dock 6 feet wide extending into the water and thus permitting casting to either or both sides, is ideal. Any attractive field area will serve in the absence of water. For accuracy bait casting, five 30-inch targets spaced off-line from 40 to 80 feet are needed; for dry fly accuracy, five targets placed off-line from 20 to 50 feet are required; and for wet fly accuracy, five targets are placed on a line 35, 40, 45, 50, and 55 feet from the casting station. Fly casting for accuracy requires approximately 40 feet of clear space behind the participant.

Field Hockey -- The official field hockey area is from 270 to 300 feet long by 150 to 180 feet wide. For junior high school age children the minimum size may be 255 feet by 135 feet. A safety area 30 feet in width should be provided on the sides and ends.

Flickerball -- This recently popularized sport requires a playing area 160 feet by 90 feet in size. Additional space 15 feet wide should be reserved around the outside of this field to accommodate play, and for safety.

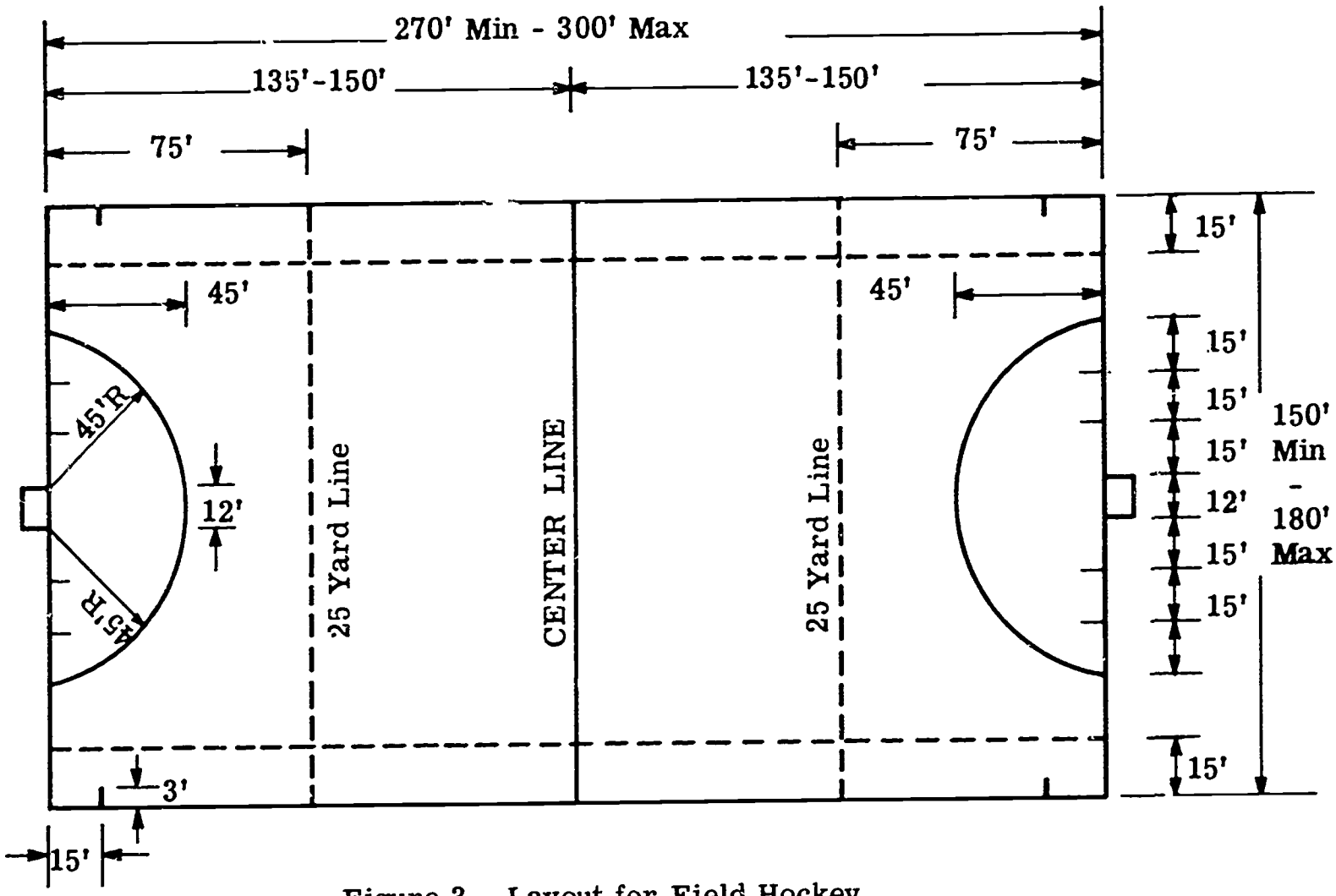

Figure 3. Layout for Field Hockey.

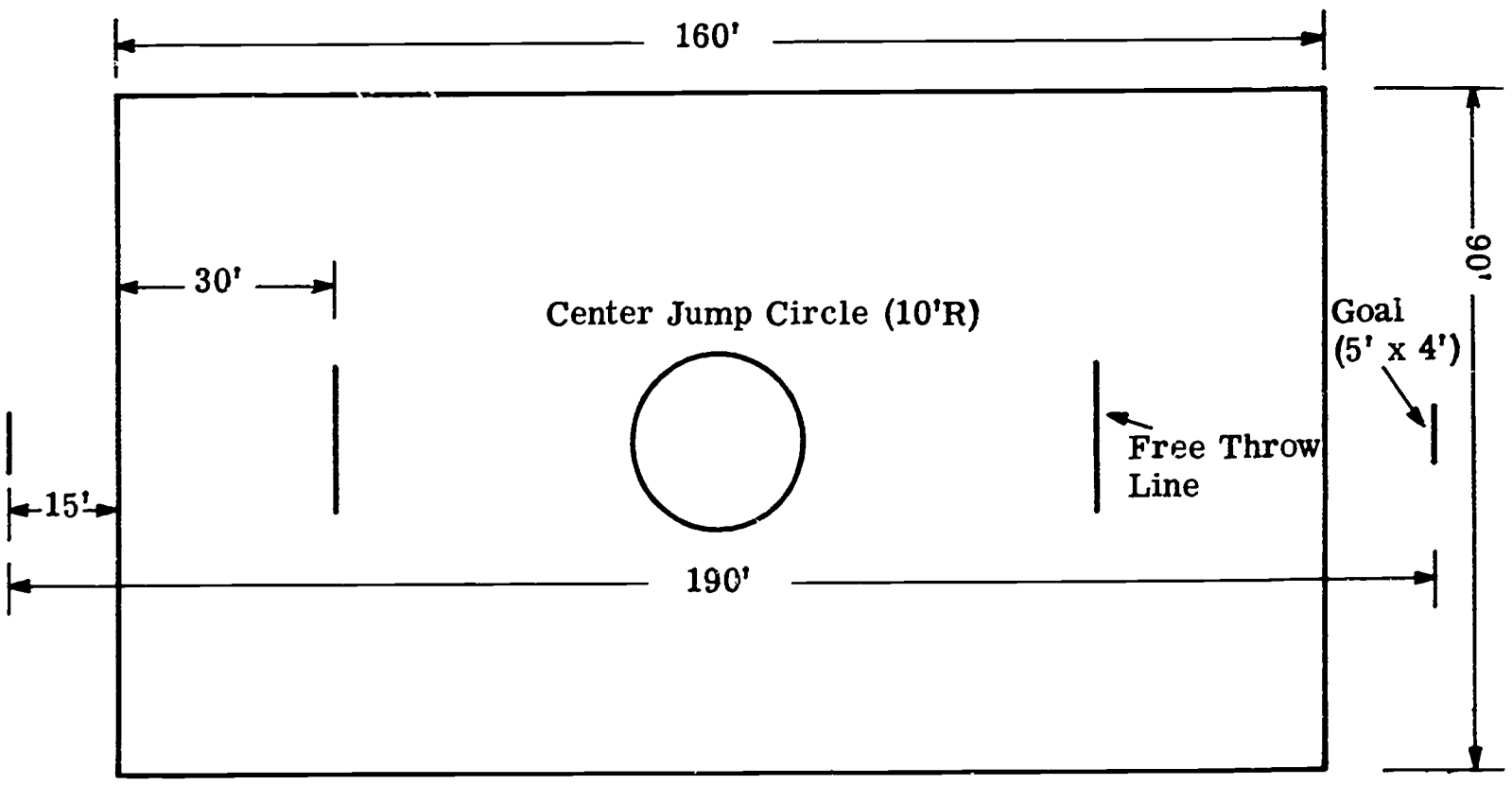

Figure 4. Layout of Flickerball Field.

Football -- The dimensions of a football field (including the two end zones) are 360 feet in length by 160 feet in width. Minimum safety areas at the sides should be 20 feet wide, and at the ends 30 feet. The minimum overall area required is 420 feet by 200 feet. In order to provide space to accommodate the kicking game, considerable clear space behind the goals and on both sides is necessary. In order to enable multiple use of the football field for such activities as field hockey, flickerball and speedball, it is suggested that safety lanes wider than 20 feet be provided at the sides.

Six-man football requires a field-of-play area 300 feet long by 120 feet wide. The National College Touch Football rules specify a regulation NCAA (300 feet by 160 feet) football field, while much smaller areas may be utilized for many flag football and touch football leagues. The minimum safety areas recommended for football are equally applicable for most modifications of this activity.

Golf -- Space requirements for golf instruction vary according to the extent of the program, ranging from an approximate minimum of 50 acres of land for a nine hole course on ground which is quite level to as much as 140 to 180 acres for 18 holes on hilly land.[1] For practice driving, an area 200 yards wide by 300 yards long is suggested for a 35 tee range, with approximately 10 feet allowed between each tee.[2] This requirement would indicate that an area 250 feet wide by 300 yards long would be needed for a single tee range, with the width being increased by 10 feet for each additional tee. Practice greens, pitching areas, sand traps, and driving cages can be located on relatively small areas.

Handball -- The standard one-wall handball court is 34 feet long by 20 feet wide. Recommendations for this sport for elementary and junior-senior high school age children specify a smaller court 26 feet long by 18 feet wide. An area 5 to 8 feet wide between courts and 10 to 20 feet at the ends should be reserved for safety and convenience. The official A. A. U. four-wall handball court is 23 feet wide, 23 feet high, and 46 feet long while the official Y. M. C. A. court is 20 by 20 by 40-44 feet in size.

Horseshoes -- An area 46 feet by 6 feet is required for a single horseshoe court. However, a safety area 10 feet wide should be provided on each side and end, (measured from stakes) thus increasing the minimum dimensions to 66 feet by 20 feet. When a battery of courts are placed side by side, a distance of 10 feet between the stakes must be provided.

Ice Hockey -- A playing surface 200 feet by 85 feet with rounded corners on 15-foot radii is recommended. Minimum requirements specify an area 165 feet by 60 feet, and a maximum area is 250 feet by 110 feet. Additional space is needed for two boxes large enough to accommodate 12 persons each near the center of the court on one side, and one box large enough to accommodate 8 persons at center ice on the opposite side.

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[1] National Golf Foundation, Golf Facilities: A handbook of Golf Club Organization, Construction, Management, and Maintenance, Herb Griffis, (ed.), Chicago, The Foundation, 1949, p. 23.

[2] National Golf Foundation, Golf Range Operator's Handbook, 2nd rev. printing, Chicago, The Foundation, 1949, p. 5.

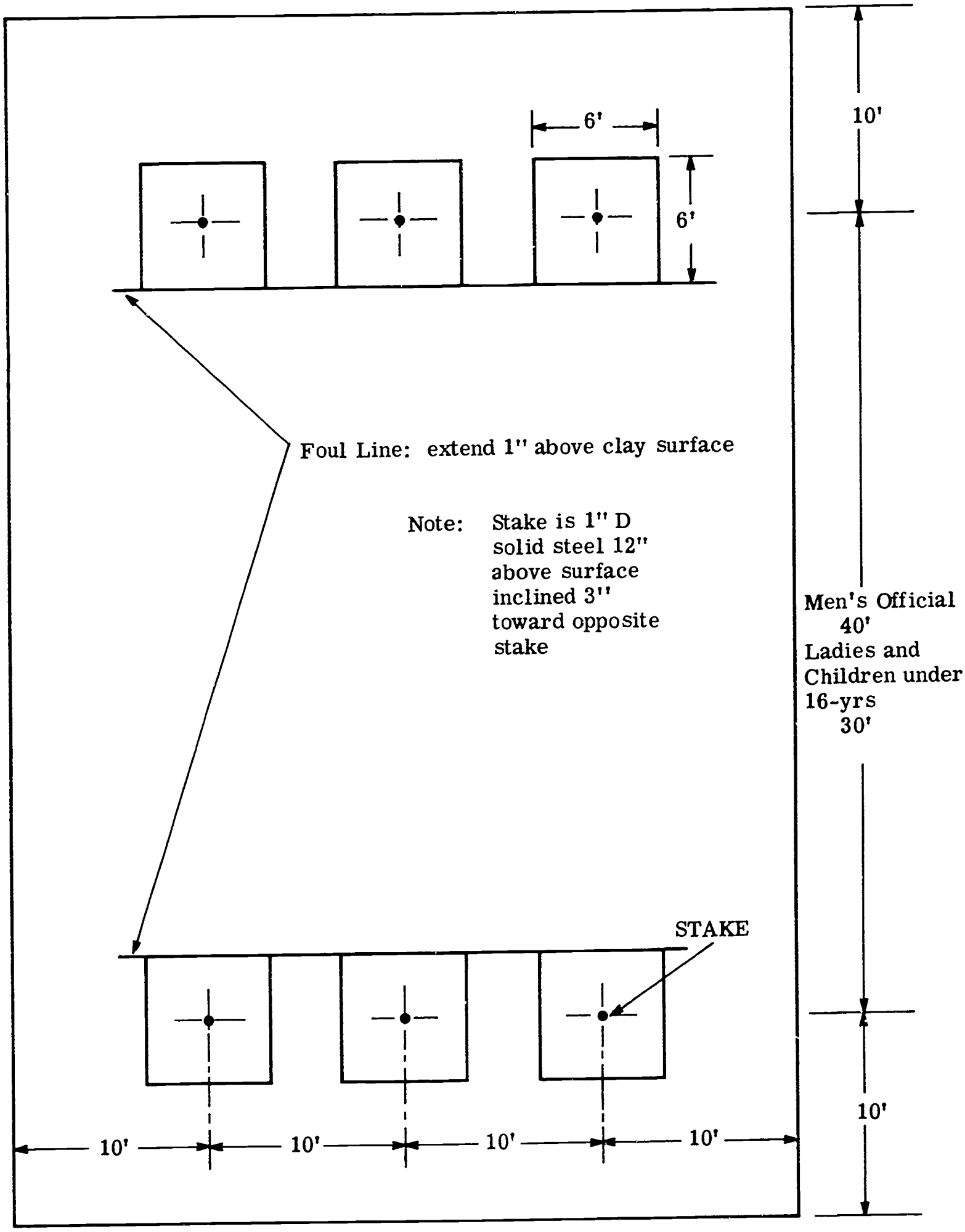

Figure 5. Layout for Horseshoes.

Ice Skating -- While there are no official requirements for recreational skating, it is recommended that 1,000 square feet of area be provided for each skater. Competitive speed skating requires a track of 8 laps to the mile with a 58 foot radius at each end and a 41 foot-6 inch straightaway, or a 6-lap track with a straightaway of 204 feet 4 1/2 inches and turns on a 73 foot radius. Both are recommended by the Amateur Skating Union of the United States. The radii are measured to the inside of the inner curb, and the straightaways are measured 24 inches inside the inner curb.

Lacrosse -- The official lacrosse field is 330 feet long by 180 feet to 210 feet wide. A minimum area 20 feet wide at each side and 30 feet wide at each end should also be provided, thus necessitating a clear and unobstructed area of 390 feet by 220 to 250 feet.

Pistol Marksmanship -- Outdoor pistol shooting requires a maximum of 150 feet from firing line to target, 15 to 20 feet more behind the firing line to accommodate shooters, and sufficient space behind targets for bullets stops. This latter requirement may range from a minimum of 2 to 10 feet for artificial backstops to a much greater length when natural stops are used. The minimum width between targets is 5 feet.

Rifle Marksmanship -- Small bore rifle shooting requires a 100 yard range with a minimum distance of 5 feet between firing points. Additional distance of 15 to 20 feet should be provided behind the firing line, and space for bullet stops behind targets vary. Ranges for high powered rifle shooting for all distances require provisions for firing lines at 200 yards, 300 yards, 600 yards, 800 yards, and 1,000 yards, with space behind targets for adequate bullet stops and space in front of firing lines of 15 to 20 feet. A minimum width of 5 feet between targets is essential, and the amount of space needed behind the targets to serve as a danger area for ricocheting slugs varies greatly. Such variance is dependent on the size and nature of the bullet stop used, and ranges from a very small area when efficient artificial or ideal natural stops are utilized to many acres for others. Because of the extreme danger involved when safe conditions are not provided, decisions with respect to this matter should be formulated most carefully. The National Rifle Association with offices at 1600 Pensylvania Avenue in Washington, D.C. is helpful in providing assistance and specialized advice in all matters of range construction.

Roller Skating -- Recreational roller skating can be accommodated on any hard-surfaced, multiple-use sports area. The hard surfaced area required for two doubles tennis courts (120 feet by 108 feet) will provide fine accommodations for approximately 70 skaters.

For speed skating, an official oval track with a minimum 20 foot width and a minimum length of 24 laps to the mile is recommended. The championship speed skating track is 14 laps to the mile.

Shuffleboard -- The official shuffleboard court is 52 feet long by 6 feet wide. An additional 3 to 6 feet should be provided at each end, between courts, and at the sides.

Skiing -- Skiing facilities for beginners should include large level areas as well as space containing gentle terrain and a flat topped hill with a 4:1 slope. Longer, steeper slopes with more space for maneuverability are needed for advanced skiing.

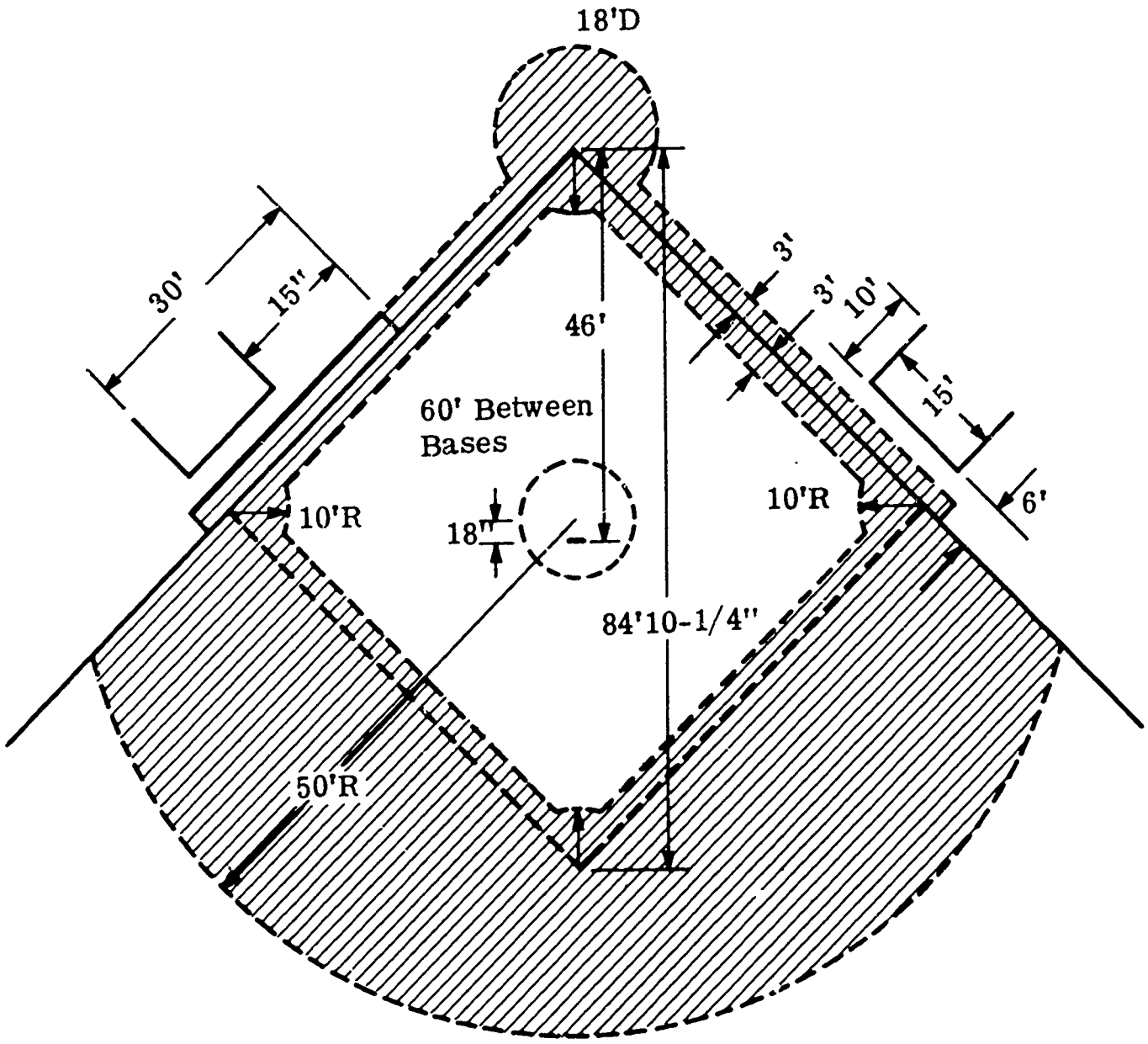

Figure 6. Layout of Softball Infield
(Showing Turf and Skinned Areas.)

Soccer -- The official rules for soccer recommend that the playing area have dimensions of 360 feet by 225 feet with a minimum required area of 300 feet by 165 feet. A safety area of 30 feet is recommended around each side and end, and additional space is needed around the field because the ball constantly is being kicked beyond the playing area. Because of this it would be unwise to locate this facility near a stream of water or a heavily used street.

Softball -- The official rules for softball require that the playing field shall have a clear and unobstructed area within a radius of 200 feet from home plate and between the foul lines. Many authorities recommend that this area be increased to provide an area with a radius of 250 feet. An area 25 feet in width should be provided behind home plate and outside each foul line. Where two or more softball fields are oriented so that the right field of one adjoins the left field of the other, the distance between home plates should be at least 450 feet.

Speedball -- The rules for speedball stipulate an area 300 feet in length by 160 feet in width, but suggest the advisability of modifying the field to 220 feet by 135 feet for intramural competition and for use by younger age groups. The latter dimensions usually permit installation of two speedball fields crosswise on the football field by placing the goal posts and the end lines 30 feet outside the football sidelines.

Tennis -- There are several types of tennis as follows:

Lawn Tennis. The official dimensions for the doubles tennis court are 78 feet by 36 feet. The United States Lawn Tennis Association recommends that 21 feet be provided behind each baseline for championship play, and that 12 feet be provided between courts and at the sides. Minimum recommendations for safety areas specify additional areas of 15 to 18 feet behind baselines and 10 feet beyond side lines and between courts. A total area 120 feet by 60 feet is recommended for one doubles tennis court, and an area 120 feet by 108 feet will accommodate two courts placed side by side.

Paddle Tennis. The doubles paddle tennis court is 44 feet long by 20 feet in width. Eight to 10 feet between courts and 10 to 15 feet at the ends should be reserved to provide for safety and to accommodate play.

Floor Tennis. This game requires an area 16 feet by 8 feet with 6 feet between courts and at the ends.

Hand Tennis. The official rules for hand tennis specify a court 40 feet by 16 feet with 7 feet between courts and on the sides and 12 feet at the ends.

Aerial Tennis. The aerial tennis court is 50 feet by 26 feet. Six to 10 foot safety areas should be provided at the sides and ends of the courts.

Tether Tennis. An area 20 feet square is recommended to accommodate a tether-tennis court.

Track and Field -- A 440-yard oval running track measured 12 inches inside the curb is practically a necessity. While a track designed with approximately 110 yards on each curve and each straightaway is recommended because it provides soft curves,

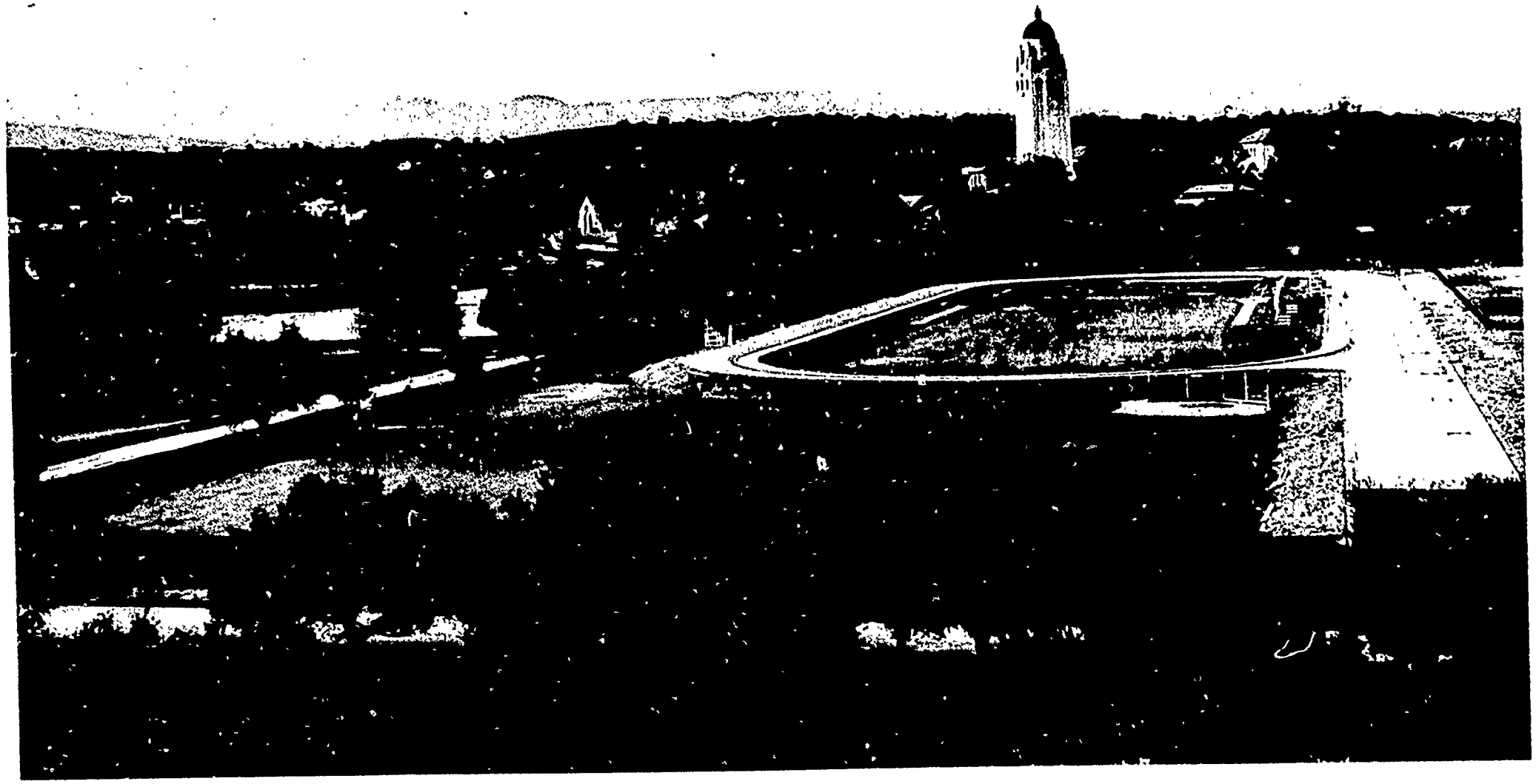

PLATE 5. STANFORD UNIVERSITY'S ANGELL FIELD PROVIDES THE ULTIMATE IN TRACK FACILITIES.
Courtesy of Department of Athletics, Stanford University, California.

the use to be made of the space inside the track may require another arrangement. Table 4 provides data on a number of satisfactory tracks.[1]

TABLE 4

RECOMMENDED TRACK DIMENSIONS

End Radius (Measurement Line)	Length of one side	End Radius (Curb Line)	Dimensions of Enclosure Inside Curb
100'	349'	99'	198' by 547'
105'	330.134'	104'	208' by 538.134'
107'	323.85'	106'	212' by 535.85'
125'	267.3'	124'	248' by 515.3'

A 220-yard straightaway with 30 yards of unobstructed tract surface provided at the finish is highly desirable. If possible, such a straightaway should be provided at each side of the track in order to enable a 440-yard run with one turn.

The width of the track should be such as to accommodate a sufficient number of 36 inch wide lanes (42 inches is preferred) to eliminate the necessity for an unwieldly number of trial heats. Straightaways 30 feet wide and curves from 18 to 25 feet wide are recommended.

The broad jump and pole vault runways should be 130 feet long and a minimum of 4 feet wide, and if possible, they should approach pits from two directions. The high jump approach should form an arc with a 60 to 80 foot radius leading into a jumping pit with minimum dimensions of 12 feet in length and 16 feet in width. When the approach area is designed in a circle with a 60 to 80 foot radius and a jumping pit in the center 16 to 20 feet square, ideal conditions can be assured. The javelin runway should be 130 feet long by 4 feet in width.

Other space requirements should be determined on an individual basis depending on the events to be included, the type meet to be conducted, and the amount of multiple-use of space anticipated. Space requirements for field events should be determined by consulting the Track and Field rules for official dimensions and layout-plans, and the official Track and Field Guide for records of accomplishment to determine the size of landing areas required. Generous landing areas and safety zones should be assured for all events, and landing pits should exceed the minimum sizes stated in the rules.

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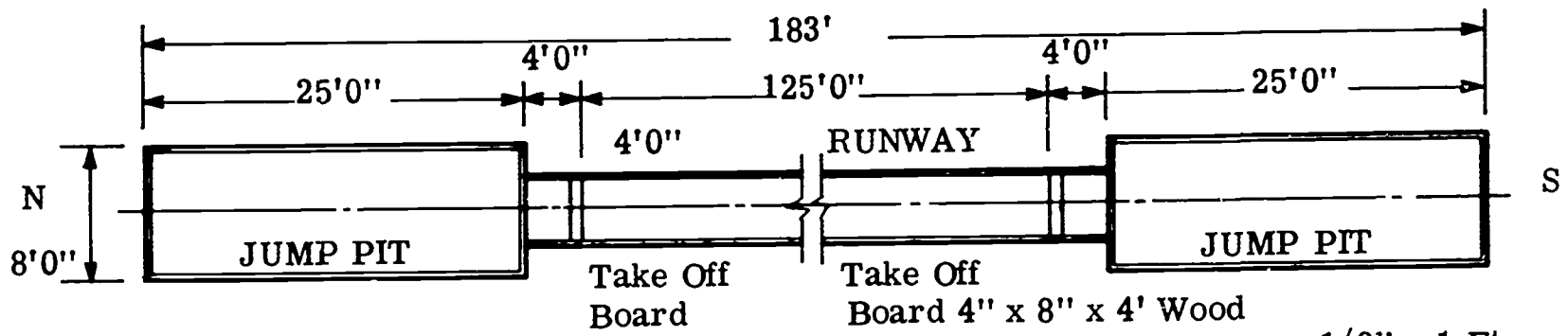
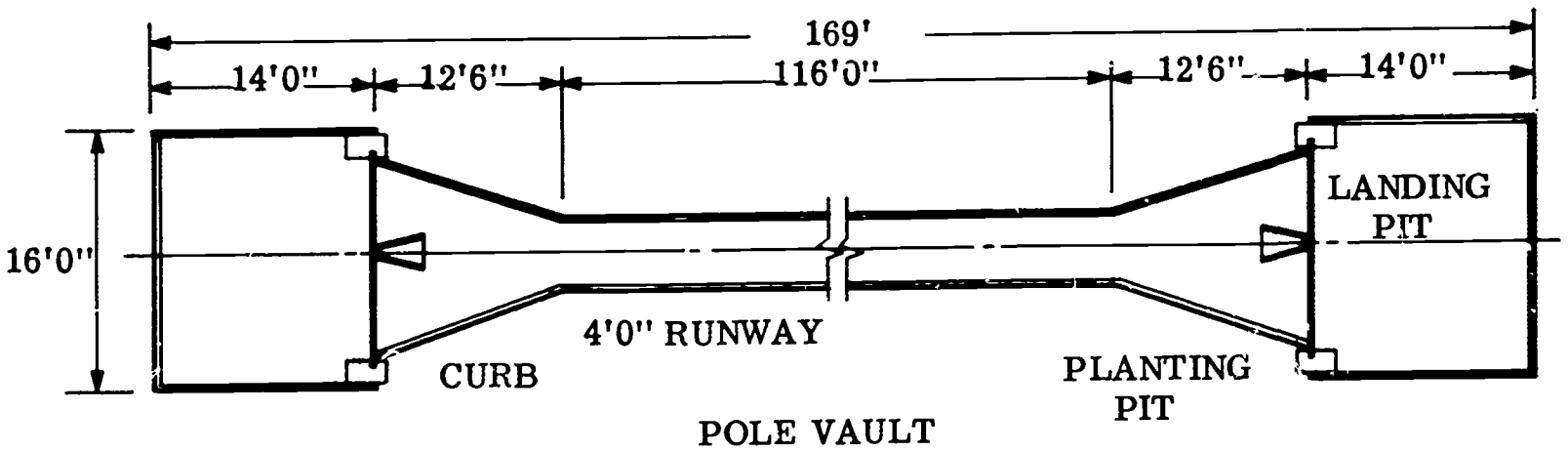
[1]George D. Butler, Recreation Areas: Their Design and Equipment, 2nd ed., New York, The Ronald Press Company, 1958, p. 136.

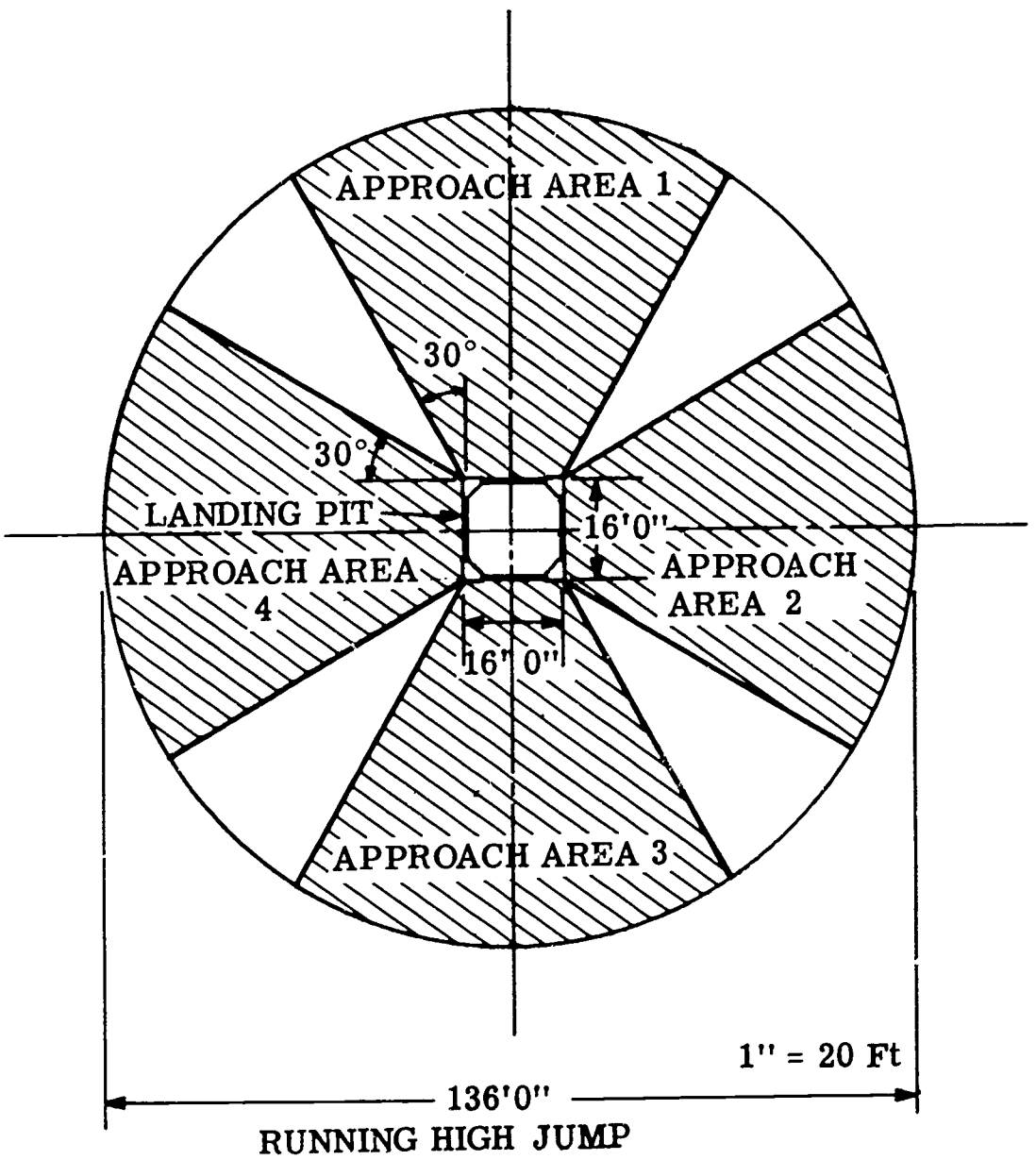
RUNNING BROAD JUMP
(Plan For Two-Directional Approach)



1/8" = 1 Ft



POLE VAULT
(Plan for Two-Directional Approach)



RUNNING HIGH JUMP

FIGURE 7. Details for Track Events.

Training and Gymnastic Activities -- Weight training, wrestling, tumbling and gymnastics, and general conditioning activities can be accommodated nicely in small, specialized areas in the out-of-doors. The actual amount of space required depends on the extent and arrangement of facilities provided, but many persons can be accommodated in these activities on relatively small areas.

Volleyball -- The official dimensions for a volleyball court are 60 feet by 30 feet. It is recommended that a minimum of 10 feet of unobstructed space around the sides and ends be provided.

The information contained in the preceding outline of dimensions provides minimum, as well as desired space requirements for the activities covered. No provisions are indicated for spectator space. This should be determined locally in each instance. Once educational planners have decided on the number of activity areas required for the program contemplated, it is possible to determine the actual amount of space needed. This is not, however, a simple problem of arithmetic. The advice of someone who understands and successfully practices the art of land development is required if the most efficient arrangement of facilities within a given space is to result. Hadden emphasized the importance of efficient planning for space utilization:

> Experience has shown that careful and intelligent replanning may result in a saving of as much as ten to twenty-five per-cent of the total ground area devoted to a given number of facilities or a corresponding increase in the number of facilities on a given area, and it is obvious that where land is valuable such a saving makes a large amount of study in design well worth while.[1]

It is true that plans for space utilization frequently proceed on the basis of insufficient field data. In order to assure against the errors and omissions which result from such failures, it is important that accurate maps of the area under consideration be developed to a specified scale.

Actual layout drawings showing the various possibilities of a site should then be made. If the survey map is drawn to scale, it is possible to place required facility units within the boundaries of the site, and since the area, as well as each field, court, building, and landscape detail are all of the same scale, a perspective of possible arrangements is obtained. This is the only efficient method of determining the fitness of a site to house a specific educational program.

Although a rectangular area with a ratio of 3 to 5 width to length is recommended by many experts as best adapted for meeting the needs of educational programs, the wisdom of establishing such a single criterion for selection is questionable. Actually the shape of a site is far less important than the size, and where a site is available of sufficient size to provide for all facilities needed efficiently and economically, the actual shape is unimportant by comparison.

Topography

The failure of planning groups to require sufficient field detail on a proposed site is an important cause for error and omission in plant development. In addition to the

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[1]Gavin Hadden, "Athletic Facilities to Meet Modern Needs in Towns and Cities," The American City Magazine, May, 1926, p. 529.

survey map, which shows the exact size of a tract of land, a topographic map should be prepared to show elevations and depressions, flat surfaces, trees, large rocks, and other physical features which determine the amount of work required to prepare the site for use in the program. As a general rule this map should show one-foot contours in order to provide the gross detail needed for efficient site selection.

Given this map, together with program specifications as to the amount of grade permissible for each activity, the experienced engineer has the field detail required to plan for earth movement and to estimate the expense of the work required. Without such detail, any estimate which is made will be lacking in specificity, and the entire plan may be jeopardized as a result.

Cutting and Filling -- Considerable speculation has centered on the amount of cut and fill which can be made economically and efficiently in adapting a site for an educational program. Gross movement of earth is an expensive and time-consuming undertaking. This was especially true prior to the bulldozer, crawler-type tractor and carry-all, and other mechanized equipment. Today, with such equipment available, it frequently is practical to accept a site which is desirable in other important respects, but which will require considerable excavation or fill to make it conform to activity requirements with respect to levelness. This may be true also of inundated territory which sometimes can be reclaimed, thus improving the general environment of a place and at the same time providing the much needed space for human use. In all instances of this nature where technical problems are involved, it is important that a competent engineer be employed to study the problem. He should estimate costs and make recommendations as to the advisability of attempting to convert this kind of space to use.

A second important consideration in planning for the use of space which requires considerable cutting and filling is the fact that it is difficult to fill a depression of considerable magnitude in such a way as to assure against future settling of the soil. This is a problem which can be solved by the competent engineer most satisfactorily when a long-range development plan has been prepared showing future uses of all available space. When it is possible to fill an area a year or more in advance of the time construction of facilities is begun, most of the settle will have resulted prior to the time surfaces and structures need to be provided. When this is not possible, the prolem may be handled by the use of the sheepsfoot roller and other modern earth tramping equipment.

A third problem is that of conserving the topsoil found at a site. As a general practice it is desirable to protect a good topsoil by moving it prior to making a cut or a fill. Many authorities consider this practice absolutely essential in planning for space utilization. Naturally the process of moving 4 to 6 or more inches of topsoil from a site prior to excavating and then replacing it after the sub-surface has been levelled is a large undertaking. The fact that a good topsoil has required many years of development under natural conditions should be considered in arriving at a decision as to whether a particular site can be utilized without this type of undertaking.

Some soil experts believe that the effective use of fertilizers and other modern soil improvement techniques make it possible to disregard the above procedure. They suggest that the soil remaining after excavation should be improved according to scientifically determined methods.

> In preparing an area for turf one of the first problems which presents itself is whether or not to save the topsoil. The physical properties and plant food content of the topsoil in relation to the subsoil are the

chief factors affecting the solution of this problem.

> In many cases the practice has been to save the topsoil on areas requiring extensive grading. The saving and replacing of large quantities of topsoil involves considerable delay and expense. Assumption that this operation is an absolute necessity should be challenged in view of the fact that in some localities the subsoil is suitable from a physical standpoint and should produce a satisfactory turf provided enough plant food of the right kind is added. The advisability of saving topsoil is particularly questionable in much of the Bermuda grass region where the topsoil itself is poor. The cost of fertilizer represents only a small fraction of the cost involved in moving or saving the topsoil.[1]

This is another problem for which no simple rule of thumb can be formulated to govern all situations. The physical and chemical characteristics of the topsoil and subsoil involved are determining factors. A soil specialist employed by the state agricultural experiment station, or the county agent's office, or various private agencies is best qualified to make recommendations on the basis of all the facts obtainable.

Location and Environment

Although the location and environment of a site should be considered less important than its size, there are several factors which add to, or detract from, its desirability. It is important that these receive proper consideration.

The National Council on Schoolhouse Construction has commented on the location of the site of a post-secondary school plant as follows:

> Where a new site is to be selected, the criteria for determining location may be of concern to the planners. These, too, like the criteria for size, will depend in part upon the nature of the institution, particularly with respect to the need for accessibility. Among the common concerns are accessibility by road and by public transportation; the availability of utilities; the absence of existing or potential nuisances in the form of noise, undesirable odors, and unsightly surroundings; freedom from hazards on the site or in approaching it; the general quality of the neighborhood, existing and potential; and the cost of acquiring and developing the site. With respect to cost, there are many factors to be considered in addition to purchase price, including need for grading, soil conditions, drainage, removal of obstructions, and constructing of access roads and utility lines.
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> The criteria for location are, of necessity, all relative, and, in the absence of very strong reasons to the contrary, adequacy of the size and character of the site should outweigh any of the location factors in the final choice.[2]

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[1] John Monteith, Jr., "Turf for Airfields and Other Defense Projects," Turf Culture, March, 1942, p. 195.

[2] National Council on Schoolhouse Construction, Post-Secondary School Plant Planning, The Council, 1960, p. 61

The physical education program suffers when facilities are located unusual distances from dressing and shower accommodations or from other campus buildings such as dormitories, classrooms, or laboratories. This is true for the required program where excessive time consumed in arriving at the site cuts into instruction and activity periods. It is true also for the voluntary program where there is surely a positive correlation between the accessibility of physical education facilities and the voluntary use made of them by students.

In addition to the problem of travel distances in determining the desirability of a specific location, it is also important to consider the manner by which those who are to use the facilities arrive thereon. The availability of adequate transportation facilities for the use of students and visitors, the absence of unusual traffic hazards and unfavorable environmental conditions en route all add to the attractiveness of a locality.

It is important that present conditions of the immediate environment and future possibilities be considered. Assurance that undesirable ownership of adjacent and surrounding areas is unlikely is a definite asset to any site. This assurance is most absolute when the school authorities or community owns surrounding land, or when the zoning regulations of the community guarantee against possibly unpleasant eventualities.

In discussing the matter of site location, Perkins[1] refers to what he calls the "microclimate" of a site. He provides some interesting data on this subject.

> A difference of only 25 feet in elevation can cause measurable difference in temperature and humidity.
>
> Vegetation too can influence site temperature measurably. Windbreaks cut wind velocity as much as 20 per cent . . . and on warm days, vegetation reduces temperature in two ways: (1) shade, or reduction of radiant heat from the sun; (2) vaporization of moisture given off by foliage.
>
> Vegetation acts as a filter, too. Measurements have shown that a 600 foot wide belt of planting can reduce dust count as much as 75 per cent. Even lawns act as dust filters.

In addition to thorough consideration of the location of an outdoor physical education site in relation to the campus, dormitories, classrooms and laboratories, and to other physical education facilities such as the gymnasium, stadium or field house; the arrangement of facility units in relation to each other influences the effectiveness and convenience of their use. The most ideal arrangements are usually best assured when ample space is available and when competent program specialists plus architects and engineers are charged with the responsibility of weighing all facts in devising a plan for such arrangement.

Where there is the possibility that a program of co-educational recreation or co-educational physical education will be conducted, it is important that some of the facilities planned primarily for use by men and some of those primarily for use by women be located and arranged so that both sexes may reach them easily. This arrangement

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[1]Lawrence Perkins and Walter Cocking, Schools, New York, Reinhold Publishing Corporation, 1949, pp. 28-29.

is desirable also because it makes these facilities available for joint-use by either sex during periods of maximum participation by either.

Soil and Subsoil

The quality of the natural topsoil found on a potential site is a definite asset or liability, and should be so viewed in evaluating the possibilities of the site. This also is true of the subsoil.

In evaluating the soil it is important to realize that the purpose to be served determines the quality of soil desired. If it is to be used for turf fields, and a certain type of grass is desired, a soil (and subsoil) which conforms to one set of specifications is needed. If, on the other hand, the ground is to be covered with an all-weather surface, a different soil will suffice. In either instance it is a poor practice to proceed on the basis of insufficient or inaccurate information when it is a simple and inexpensive process to obtain accurate and complete analyses. Many cities and all states maintain official agencies and employ experts whose services can be obtained by institutions at little expense. A request to the state agricultural experiment station, or the county agriculture agent's office for these services will usually result in the receipt of instructions to be followed in obtaining the information needed.

In light of the specific nature of the information required for intelligent planning of outdoor physical education facilities, the general information included in this section is of value only in the preliminary phases of planning and for the purpose of providing a background for an understanding of the subject by the program specialist.

Quality topsoil is required wherever grass, flowers, shrubs, or trees are to be grown. A study of expert opinion with reference to this matter reveals that a "sandy loam" sail is recommended for all areas where athletic turf is desired. This is so, despite the fact that this type of soil is not always available.

> Soils on which turf must be grown vary from heavy clays, to loose sands through a wide variation in mixtures of sands, silts, and clays. Soil mixtures which combine the sand, silt, and clay in certain proportions are loams. When, by fortunate accident, a sandy loam type of soil is present, it provides the most favorable physical condition for grass turf. [1]

When a soil does combine such ideal proportions together with sufficient organic matter, it is best for the growth of turf because it retains a sufficient amount of moisture yet permits the drainage of excess water; it does not harden, crack, or bake easily; and in general it provides a good seed-bed for the germination of grass seed.

Since ideal soil rarely is found, it is necessary usually to improve that which is actually available. Before this can be done, it is practical to determine wherein a particular soil is deficient, and to assist in this process, tests have been devised. For those who desire to make use of the laboratories of state agricultural experiment stations the following simple instructions may prove helpful.

> In turf, the surface one or two inches are most significant so far as chemical analyses are concerned. To represent the area in question,

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[1] John Monteith Jr., op. cit., p. 196.

> five or more plugs of the surface one or two inches of soil should be removed from an area of 1,000 square feet. These can be cut approximately one inch square with a knife or with any other device you care to use. It is well to wrap each plug separately in waxed paper to preserve it intact in its original condition and to prevent crumbling. If the tests are to be an aid to a general fertilizing or liming program it is not necessary to test every green and fairway, but only representative ones for each type of soil.
>
> Samples of soil are of no value unless properly labeled. When you send them to... your state agriculture experiment station they should be accompanied by certain information to aid the laboratory man in interpreting the results of the tests and in formulating recommendations for you.[1]

Although the specific nature of the information needed by the laboratory is not indicated in this excerpt, it should describe the place from which the samples were taken, describe the use to be made of the area, and include specific questions regarding the nature of the assistance desired.

While most persons recognize the role of topsoil in plant development, many fail to give due cognizance to that of the subsoil. Whether an area is to be developed into turfed fields or hard surfaced courts, it is important that information on the nature of the subsurface be considered in determining a plan for its development.

For turf areas, a subsoil which will encourage the growth of a healthy, deep-rooted grass cover is needed. Unless the subsurface structure is such as to provide for efficient drainage and circulation of air, grass roots may be smothered or drowned. When hard-surfaced court areas are to be constructed, good drainage also is necessary, especially during the seasons of extreme cold weather when ground water which remains within the frost line area may freeze with resulting damage to the surface. Where the natural drainage potential of a site is good, much expense can be avoided by eliminating the need for extensive artificial drainage.

Water and Utilities

A generous supply of water is required for human consumption and comfort, and for the development and maintenance of turf and other landscape detail. In addition, storm and sanitary sewers are needed to carry away excess water and sewage.

In planning for an adequate supply of water, the nature of the variables which determine the quantity and pressure of the water at the discharge point are such as to require the assistance of an experienced engineer. In addition, the amount and pressure of the supply of water needed depend on factors which are often unique to a particular institution. Because of this, generalizations in the form of recommended standards have limited value. The following selection points out some of the problems and recommendations commonly encountered.

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[1] "Sampling Soil", Timely Turf Topics, August, 1940, (A publication of The United States Golf Association Green Section, Plant Industry Station, Beltsville, Md.).

It is necessary to make provisions for an adequate pressure at all outlets. Pressure is generally stated in terms of pounds to the square inch. For watering either with a hose or sprinkler, it will be found that satisfactory results will be obtained with a pressure of about sixty pounds at the hydrant.

In order to deliver this pressure, pipes smaller than one and one-half inches in diameter should not be used as the friction produced in a smaller pipe will cause a corresponding reduction in the pressure. Under a sixty pound pressure a flow of three to four cubic feet of water per minute should be obtained through one and one-half inch pipe.

When installing the pipe lines, ample provision should be made for maximum expansion. A main smaller than five inches in diameter should not be considered, a good grade of galvanized wrought-iron pipe should be used with four inch sub-mains. These sub-mains should be provided with ground box unions which can be uncoupled in winter, as well as gate-valves, so that it is possible to cut off any sub-main for repairs in case of accident, without shutting down the entire system. It is recommended that wherever possible the pipes be laid shallow, in order that the higher temperature of the surface soil will dissipate some of the chill which water drawn from a great depth usually possesses. The pipes should be laid in such a manner as to permit their complete drainage in the winter time.[1]

Where a water supply with a pressure adequate to deliver water at the place of use is limited to such an extent that some or many of the features of the development must be curtailed, a site naturally loses some of its value. Inasmuch as adequacy in this matter is relevant, it should be determined as the result of a study of all pertinent factors. Where a pressure of sixty pounds may be adequate for one situation, it may be more or less so for another.

Electricity is another necessity for the efficient administration of the modern program of physical education. It is needed wherever activity is to be encouraged in the evenings, where public address systems will be required, and wherever spectators gather. In addition, the comprehensive program of physical education require provisions for telephone services in press and radio boxes, in offices of administration, and for the convenience of spectators and other visitors.

The availability of these types of services adds to the acceptability of a potential site, and where considerable expense and effort must be expended to provide them, the cost of developing the site may be appreciably increased. Since the most desirable of plans for outdoor physical education facilities call for the installation of underground wiring and permanent sprinkling systems which remain below the surface of the ground permanently, it is important that the availability of water, electricity, telephone, and other necessary utilities be determined early in the planning process.

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[1] C. C.Kelley, "Construction and Drainage for Athletic Fields", Unpublished Master's Thesis, Springfield College, 1933, pp 13-14.

CHAPTER IV

COMMON PROBLEMS OF SPACE UTILIZATION

Problems which are commonly present in most site development projects include those concerned with grading, drainage, and landscape design.

Grading

With few exceptions, outdoor physical education activities are promoted best on field and court surfaces which are relatively level. Because of the problem of drainage, however, it is usually necessary to provide for a gradual slope which will assure the efficient removal of excess surface water from playing areas. Exceptions occur in arid and semi-arid regions, and in some instances where soil conditions permit rapid drainage of surface water through to the sub-surface. While each project development will present problems of drainage which may be somewhat unique, there are recommendations for grading which normally prove acceptable.

For unpaved surfaces a fairly constant slope of 1 to 3 per cent is recommended. Any grade of less than one per cent is generally too flat, while grades in excess of three per cent for any appreciable distance frequently result in the erosion of surface soils. Surface grades on hard surfaced areas should be from a minimum of 3/8 of 1 per cent to a maximum of 1 per cent.

For the turf football field, a 12-inch crown down the longitudinal axis in the middle of the field will usually suffice. In this instance, a one-tenth foot fall from the middle in the first 25 feet, two-tenths foot fall in the next 25 feet, three-tenths in the third, and four-tenths in the fourth segment of 25 feet suggests probable acceptable ratios.[1]

Some turf fields are graded to a "turtle-back" design with a crown at mid-field and slopes in four directions. Where heavy rainfalls occur frequently, or where inadequate provisions for the drainage of a large stadium structure indicate that huge amounts of water will converge upon a playing area, this arrangement may be necessary. Wherever a longitudinal slope is required,however, it should be the least amount necessary in order to provide the best possible conditions of play. Other large areas meet activity requirements most adequately when the slope is on a true plane in a single direction.

For baseball, the pitcher's plate should be elevated 15 inches above the base lines and home base, and the slope from the pitcher's plate to the base lines and home base should be gradual. In order to assure adequate surface drainage in the outfield area,

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[1]Leon Burgoyne, "St. Joseph's New Stadium", Scholastic Coach, January, 1960, p. 8.

PLATE 6. STANFORD UNIVERSITY'S SUNKEN BASEBALL DIAMOND UTILIZES THE STEEP SLOPE NECESSITATED BY AN UNEVEN ORIGINAL TOPOGRAPHY IN A PLEASING AND EFFICIENT MANNER. Courtesy of Department of Athletics, Stanford University, California.

many excellent baseball parks are designed with water collection points at the base-paths and at the perimeter of the playing area on all sides. A surface grade of 1 to 3 per cent is provided in the outfield to move surface water to these collection points.

To prevent unnecessary soil erosion, a slope for turf surfaces should extend not more than three hundred feet, and two hundred feet probably should be the maximum distance for a slope on a natural earth surface. Whenever it is necessary to provide for a substantial drop in elevation within an area, it is desirable to have a short, steep slope rather than one which exceeds the recommended 1 per cent to 3 per cent for the area generally. Water collection should be handled at both the top and the bottom of such a slope in order to assure that only water which actually falls on this bank runs down it.

Hard surfaced court areas may be graded in a number of ways depending on the location of logical water collection points and the functional requirements of the activity to be conducted thereon. Most authorities recommend that surfaces to be used for tennis and other net games be graded with the slope extending from one side to the other.

> The court surface playing plane should be one which gives neither an advantage to, nor imposes a handicap on either contestant, irrespective of the court side occupied. Any other situation operates for or against a player, thereby creating unfair playing conditions. Therefore, from a sportsmanship standpoint, this consideration is very important. But from a practical standpoint it is almost equally important that the surface slope design... be one that will assure quick and equally even, uniform drainage from the entire playing area. The ideal design for slope would, therefore, be one that meets both requisites.
>
> Sloping from side toward side... seems to most nearly meet these requirements.[1]

This arrangement is functionally superior to a plan in which one end of the court is lower than the other.

When a multi-purpose, hard-surfaced area is to accommodate several activities and thus cover considerable ground, it is usually advisable to have the slope across the short side. The terrain or the location of existing storm sewers, however, may indicate the necessity for another arrangement.

When such a surface is to be used for ice skating in the winter, it is important that the lowest spot be located at the center of the area. When this is done, sufficient drainage outlets should be provided which lead to a sub-surface drainage system. Such outlets should be designed to provide complete control of the drainage system for the area at all times.

The running track presents additional problems of grading. There is recorded in the literature on this subject some skepticism over the practice of grading a track with a transverse slope. Those who oppose this practice point out that when such a

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[1]United States Lawn Tennis Association, Construction and Maintenance of Tennis Courts, New York, The Association, 1956, p. 4.

grade exists the movement of surface water from the outside of the track toward the inner curb causes a shifting of the unstable clays toward the inside and results in a slow running surface at the inner lanes. Because of this, many track authorities recommend a level track with a porous surface but with a sub-surface designed to permit the quick passage of surface water down into it. When a slope is utilized, it should be very slight in order to minimize this type of soil erosion.

The importance of a true sub-surface grade is indicated by the amount of attention given to this matter in design and construction practices. As a general rule the sub-grade should parallel the finished grade. This is especially true when the subsoil is not porous and will not permit water penetration downward. Wherever low spots exist on such a sub-grade, moisture collects, the topsoil does not drain properly, and soft spots appear during wet weather. These conditions are difficult to correct and are especially discouraging where an attractive and healthy turf is desired. This is true also for hard surfaced areas where a poor sub-grade provides an unstable foundation for the surface course and subjects the area to the hazards of damage from freezing. While most planners give considerable attention to the problem of surface grading, they sometimes neglect the sub-surface grade. This failure may result in facilities which are unavailable for substantial periods after rains, and which require more maintenance care and never attain the degree of excellence desired until inadequacies are corrected.

Drainage

For localities where ideal soil and climatic conditions are found, the problem of drainage requires little attention. For most localities in the United States, however, local conditions necessitate specific planning in order to provide activity areas which drain quickly and efficiently. This is a necessity if outdoor physical education facilities are to be available for use during a maximum of the time they are needed.

Among the reasons why this matter should receive special attention, the following are pertinent.

1. Drainage increases the average period of annual use by facilitating the removal of excess surface and ground water.

2. Drainage reduces maintenance costs by improving conditions of growth for turf and trees, by decreasing the danger of winter killing and excessive damage to surfaces during prolonged and intensive cold periods, by decreasing damage caused by flooding during wet periods, and by minimizing the occurrence of soil erosion.

3. Drainage aids in the development of a deep-rooted and healthy turf by keeping the soil firm, "sweet", and warm; by facilitating the circulation of air within the soil; and, by aiding in carrying plant food and water into the soil where it is needed.

4. Drainage helps to keep the level of the underground water table uniform.

5. Drainage reduces the undesirable packing which results when an excess of water is permitted to remain in the soil and the subsoil.

Surface Drainage -- Surface drainage is best assured when physical education surfaces are graded in such a manner as to encourage the runoff of surface water, when the top-soil is of a texture which permits the passage of surface water downward into the subsurface, and when catch basins are provided to collect surface water and transport it to the subsurface or to storm sewers. Standards for grading physical education surfaces have been discussed and recorded in the previous section and need not be repeated here.

In addition to surface drainage which results from proper grading, however, there is that which is effected naturally and efficiently when the soil and the subsoil are of a texture which permits the movement of moisture from the surface down into underground streams or storm sewers. When planning for drainage, it is important that tests be made of the soil and subsoil, and that the results be studied by someone who thoroughly understands local climatic conditions, the technical problems of drainage involved, and also the program requirements.

Surface water can be removed to underground drains and sewers by the strategic placement of drain inlets. There are practical ways by which this can be accomplished on physical education field and court areas without interfering with activity requirements or adding hazardous obstacles. All drain openings should be designed with removable, rubber-capped tops which can be kept in place when an area is in use, or removed when it is not in use. These should be designed to simplify cleaning by providing openings large enough to admit a maintenance employee to carry out this chore when the need arises.

Another practical method of carrying surface water to underground streams or to storm sewers is by the construction of ditches which are back-filled with cinders, crushed rock, or other porous materials to permit the swift passage of water downward. This method is frequently used where soil and subsoil conditions retard the efficient passage of moisture through them. It is especially recommended in the construction of running tracks, base paths for baseball and softball, and clay or turf tennis courts; also wherever water from stadia or other structures is permitted to enter a field or court area, and at any low spot where water is likely to converge and remain. Such pits may be surfaced with turf or crushed stones and thus complement a landscape design. They may also border fields and serve a dual function as safety zones adjacent to fences and other structures to warn participants of danger areas.

Subsurface Drainage - - When considering the problem of subsurface drainage, the texture of the subsoil, the level of the water table and all factors which determine the amount of water to be forced into the subsurface should receive careful attention. The variations in subsurface drainage systems are exemplified by comparing two well-known physical education facilities.

> The Yale Bowl... has no drainage system; the water table lies 14 feet below the surface of the field and excess moisture quickly sinks through a 14 foot gravel subsoil. On the other hand, the Yankee stadium has two systems of drainage pipes. One is of eleven 9-inch lines laid down in the outfield, and the other of twenty-four 6-inch lines in the infield, pitching from the box toward the baselines. It is so well drained that an ordinary rainfall ceasing an hour before starting time will not prevent a game. [1]

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[1]George E. Little, and Clifton V. Barrett, "The Development of Outdoor Areas for Physical Education", American School and University, 8th ed., New York, American School Publishing Corporation, 1936-37, p. 208.

From the standpoint of the program specialist, it is essential that an efficient drainage system be developed. Although the details of design should be specified by an experienced engineer familiar with the drainage problems involved, the rudiments should be generally understood by the program specialist. The following section is included to illustrate how some subsurface drainage problems have been solved, and to further emphasize the need for technical advice in determining a system which will serve best at a given location.

In addition to increasing the functional usefulness of a facility, subsurface drainage is usually economical in the long run.

> Under the heading of drainage and grading it is difficult to lay too much importance upon this subject. As a matter of fact, a thoroughly drained subgrade will permit the placing of a much thinner wearing course, so that actually it is a cheaper proposition. It is far better to spend money for conditioning the subgrade, followed by the use of a relatively thin playing course, rather than to construct heavy base courses in the effort to fight a bad drainage condition. [1]

The usual method of planning for artificial subsurface drainage is by the use of tile pipe placed in the subsoil in such a way as to aid in the removal of ground water from the area. The following excerpts are quoted to illustrate some of the generally accepted procedures for dealing with this problem.

> Care should be taken to prepare the earth subgrade accurately in line and grade so that no water pockets will be formed. Subdrainage below the pavement proper, should be provided through the use of a porous subbase (such as sandy gravel, stone, slag or coarse cinders), or by a system of tile perforated corrugated pipe drains which will quickly lead water away from the foundation. For large areas, other than play courts, such underdrains are spaced usually from 15 to 30 feet apart depending upon ground-water conditions. The bottom of drainage ditch should have a slope of not less than 1/8 inch to the foot and preferably 1/4 inch. It is of course important to provide adequate outlets, either to city storm sewers or open ditches, to be sure of immediate run-off. [2]

> Since ground water drains to main lines more slowly and more constantly than surface water, smaller pipe may be used to remove surplus water from the soil. Four-inch tile is considered the minimum for ground water drainage; 6-inch tile for drainage from inlets and catch basins. The amount of drainage desirable under a recreation area depends upon the type of soil and the water level. The deeper the tile drains are laid the slower the action, but the

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[1] National Recreation Association, Surfacing Playground Areas -- A Supplement, M. P. No. 219, New York, The Association, 1948, pp. 6-7.

[2] Asphalt Institute, Asphalt Institute Quarterly, July, 1950, p. 5.

wider the area drained. In heavy soils the laterals are required at more frequent intervals than in lighter soils; they are generally laid approximately 3 feet in depth and at intervals of 15 feet or less in stiff clay. Agricultural tile or vitrified tile with open joints is most commonly used. Important considerations in laying tile are: making the excavation to the exact depth required, using an accurate grade line and straight drainage lines, providing space between ends of drain tile and avoiding too many main outlets. Drainage ditches are back filled to within a few inches of the surface with coarse gravel, crushed rock or cinders. Usually the drainage lines for surface and ground water are combined on a recreation area.[1]

Where unusually difficult conditions are found in the subsoil, other procedures are sometimes required. The method described below is receiving serious attention by an increasing number of engineers and certainly warrants inclusion in this discussion.

In highly capillary soils where tile drainage functions to the least advantage, a method had been devised of constructing a cut-off level some twelve inches below the surface using an asphalt application. The top twelve inches is then finished with a low capillarity material and consequently keeps in a reasonable dry condition because the capillary water in the difficult subgrade is diverted against the asphalt leveling course over it. This sort of work will increase rapidly as its merits are more appreciated, and as asphaltic products have become so low in cost, their use over extended areas is now of relatively small expense.[2]

Although most specifications for all-weather court surfaces require development of the subsoil to a stipulated depth, thus necessitating considerable excavation, where a water table is low enough to assure a firm and dry subsoil within the area of the frost line, the following method suggests a more simple and practical way to handle this problem.

In sandy or gravelly soil, under-drainage may not be required, but in heavy clay soils it is desirable to dig a ditch entirely around the court, with such bottom slope and outlet as will prevent accumulation of water. The ditch should be 2 or 3 feet in depth, with a perforated corrugated iron pipe, or open clay tile at the bottom, and should then be back-filled with broken stone or coarse gravel to within a few inches of the surface. As the asphalt top will be impervious to water, surface drainage may be obtained by finishing to a suitable gradient.[3]

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[1]George D. Butler, Recreation Areas: Their Design and Equipment, 2d. ed., New York, The Ronald Press Company, 1958, pp. 8-9.

[2]National Recreation Association, Surfacing Playground Areas -- A Supplement, op. cit., p. 7.

[3]Asphalt Institute, Asphalt Institute Quarterly, July, 1950, p. 6.

When planning for subsurface drainage for a running track, it is necessary to understand the unique problems involved. The objectives for designing the track require that it be "fast" but at the same time resilient enough to minimize fatigue and prevent injuries to the feet and legs of the runners. When the ideal combination of materials and construction detail are found, a track can be developed which meets requirements of function and economy. The following excerpt reveals the nature of the running track.

> . . . the liveliness of a track depends upon the moisture content. If anything, a well built, deep cinder track is faster when quite wet than when dry, provided the surface itself is not smeary or sticky.
>
> A track may be said to resemble a tempermental person, and must be treated as such. It takes observation, study, and much puttering with surface and watering to ease out of a track its best behavior. Since the moisture content of the track is so vital, it should appear reasonable that extremely thorough subsurface drainage is advisable. A surface that is too dry can be hand-sprinkled, but a running bed that drains poorly is a sick track and hard to cure. [1]

It is evident, therefore, that the structure of the subsurface of a running track should be such as to assure quick drainage and provide a highly resilient surface. Authorities are divided in their recommendations as to the best method of developing the various strata of a track. In recording the results of a survey on the problem, the National Collegiate Athletic Association concludes that:

> The necessary depth of the total fill depends upon several factors. A track built in and on a non-porous soil doubtlessly should be deeper than one on a porous base. Some coaches insist upon a fill of thirty to thirty-six inches, while others suggest half that depth. It is probably true that a deep track will have a longer life than a shallow track, and will be livelier also. [2]

A more recent report suggests the possibility of less costly excavation in the construction of tracks.

> . . . recently, construction superintendents have excavated to 6 inches or less and installed subsurface drainage tile. But they have built the track partially above the ground. In addition to saving on excavation, they claim the high level track reduces the possibility of flooding and permits a rapid escape of surface water. [3]

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[1] National Collegiate Athletic Association, Official Inter-collegiate Track and Field Guide, New York, American Sports Publishing Co., 1930, p. 64.

[2] Ibid, p. 62.

[3] George T. Bresnaham, "Maintenance of the Outdoor Plant", Scholastic Coach, April, 1949, p. 28.

The fee for a competent engineer familiar with the methods of solving the wide variety of drainage problems encountered is a small matter in light of the efficiency and economy which results when the problem is solved in as nearly an ideal manner as possible. To assure excellent conditions of play on physical education areas, the program specialist should request that they be constructed to drain as efficiently and quickly as possible, and the drainage engineer should be employed to work out the details.

Landscape Design

The primary objectives to be realized in designing physical education facilities are those which are concerned with the functional aspects of the activities to be served. While those which are concerned mainly with appearance should be relegated to a secondary role, there is an increasing awareness among educational planners and architects that it is not necessary to slight either function or beauty in designing these facilities. This point of view is expressed in statements dealing with the function of the landscape designer.

> The functional requirements of recreational facilities is that they provide adequate and proper play space in the proper relationship, between units, from the standpoint of administration and supervision. The landscape requirement is that all of this be done in a manner that is attractive and that takes advantage of every opportunity to combine beauty with functional processes.
>
> Landscape design attempts to coordinate the many factors that compose the picture into an efficient and pleasing composition that not only will work in a practical way but will be pleasing and attractive to behold. [1]

The College Physical Education Association emphasized the importance of appearance to the college plant as follows:

> Proper landscaping helps provide a better environment for enjoyment; serves as a socializing influence; inspires departmental and civic pride; enhances the values of adjacent property; stimulates adequate financial support; helps eliminate noise, screens out objectional views and forms a frame for interior areas. [2]

When it is recognized that landscape design is the process by which all program and aesthetic needs are expressed in the utilization of land for human enjoyment, it is difficult to outline its exact scope or to summarize the principles of art composition which are utilized. Butler summarizes the problem with respect to recreational areas as follows:

> The first step in the designing of a recreation area is to determine the location of the major features, the center of interest, the actual

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[1] Ralph D. Cornell, "More Than Planting Pansies", American City, December, 1947, pp. 118-119.

[2] Karl W. Bookwalter, (ed.), College Facilities for Physical Education, Health Education, and Recreation, College Physical Education Association, 1947, p. 105.

allocation of the building, the playing fields and the pattern of walks. Every successful composition has a center of interest, and in the case of the recreation area this is usually the principal building. In the formal design of the small area this building should be so located as to become a part of the main axis of the design. It need not necessarily terminate the axis but it should be a part of it. It thus becomes the focal point or center of interest, and because it is usually the center of activity such a location has a decided functional advantage.

In the recreation area, the pattern of walks is determined primarily by the arrangement of the various sections or divisions of the area. The walk approach to the building becomes the principal axis of the design; the other walks, which are reduced to a minimum in surface area and are therefore subordinate to the principal approach, become a minor axis.

Upon this skeleton plan are then superimposed the various elements that transform the playground into a pleasing and harmonious composition. The most valuable contribution is the introduction of plant materials, and because planting space in the average recreation area is decidedly limited, this becomes a problem of major significance. Planting helps to emphasize the third dimension, height, through the addition of vertical lines and upright masses. Plant materials correspond to the frame about a picture; they also divide one area from another, screen unsightly objects, act as a transition between sections having intensive and slight use, tie buildings and structures to the ground, and supply color, form and fragrance. [1]

Since features of landscape design should supplement and complement the functional requirements of the program, it is necessary to analyze these requirements early in the planning stages. The provision of sufficient space between activity and landscape areas to protect participants from landscape detail and vice-versa should be the first of these requirements considered. Chapter III has data on minimum and desired activity and safety areas. Fences, terraces, walks, and planted materials should all be placed outside these recommended areas. A need for considerable additional space is indicated if an orderly, attractive setting for each facility unit is to result.

Wherever humans desire to congregate, and wherever their actions may cause damage to turf or other planted areas, appropriate controls should be provided to protect against damage to facilities or danger to visitors. The surest and most widely used controls around physical education facilities are high, strong fences which designate entrances and exits, and enforce their use. Where walks are provided they should be sufficiently wide to enable three or four persons to walk abreast, they should take the most logical and direct route to their destination, and at all changes in direction the angles should be sufficiently rounded to encourage the use of the walk and reduce the tendency to cut across planted areas. Where turf may be damaged along walks, on slopes, and at intersections, a ground cover substitute should be considered.

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[1] George D. Butler, Recreation Areas: Their Design and Equipment, op. cit., p. 146.

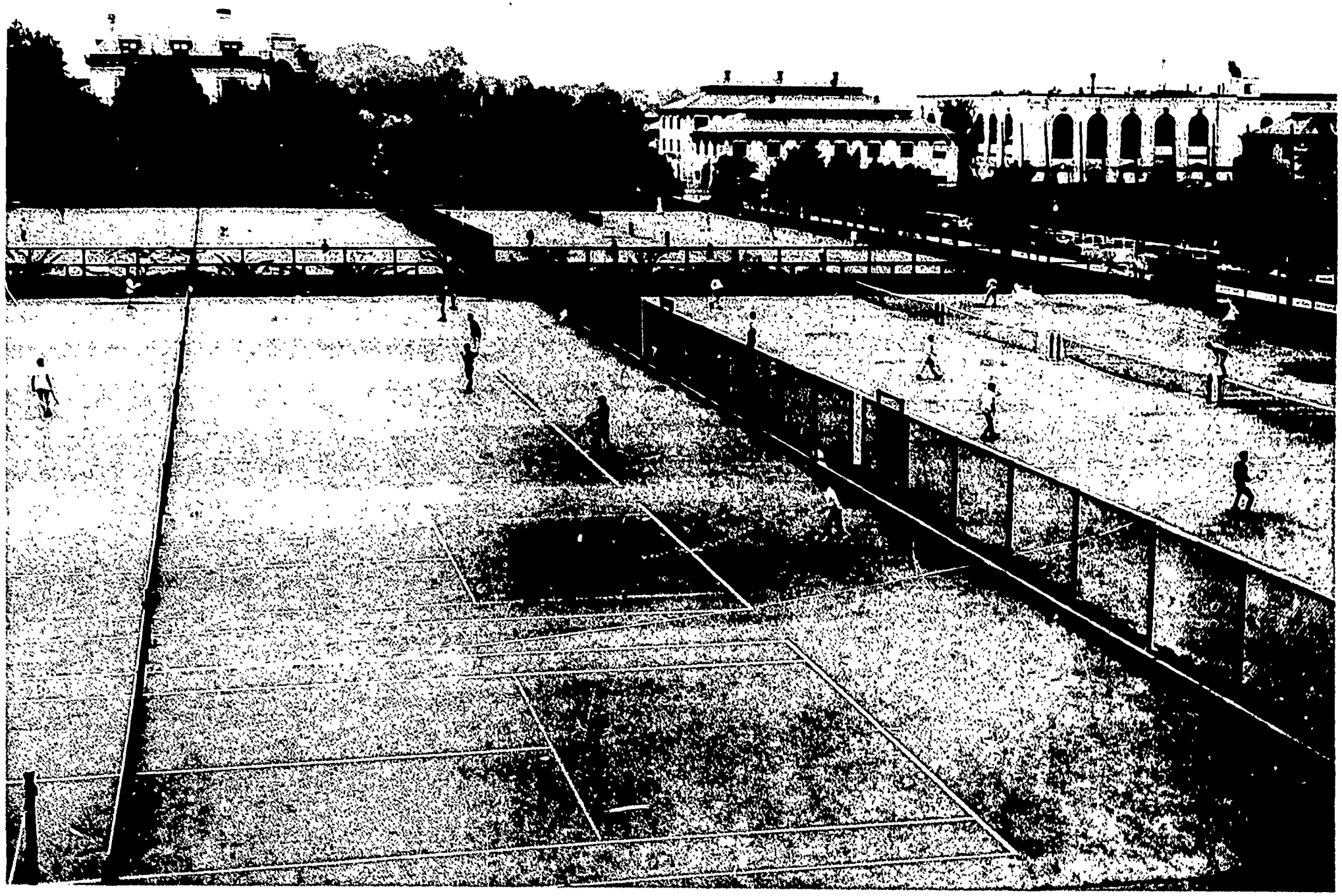

PLATE 7. CHAIN-LINK FENCE EFFECTIVELY SEPARATES FACILITY UNITS. U.S. Naval Academy, Annapolis, Maryland. Courtesy of American Bitumuls and Asphalt Company, San Francisco, California.

Finally landscape design should contemplate the very best conditions for efficient vision. Where tall trees are planted too close to fields and courts, the early morning or late afternoon sun may cast shadows over a vital area and thus detract from the functional efficiency of the facility. Where color in landscape design is desired, it is important that it be selected and located with the knowledge that if it should appear in a vital background area, it could very well become either a nuisance or a hazard. This is especially true for the space around baseball and tennis areas, as well as for other activities that involve small objects that travel at great speed. While planting is often a desirable means of separating facility units, it is important to select varieties of trees and shrubs which carry out a specific need most advantageously. Where supervisory control is desired over several facility units, a low variety of plant should be selected to permit unobstructed vision; and, where it is desired to isolate areas in a pleasing manner, taller varieties are indicated.

While the detail of a planting program is determined most efficiently by a landscape architect who has had experience with local conditions and who understands program requirements, the recommendations which follow may prove of general worth.

1. Select native varieties of grasses, trees and plants, as these are better adapted to local conditions, are more rugged, and usually require less care and maintenance.

2. Avoid the fast growing varieties as they often have short lives, are fragile, and produce heavy and extended root systems which cause damage to drain and water systems.

3. Avoid selecting fruit and nut bearing trees, those which have dangerous thorns, and the conifers in general as each of these has undesirable features to be reckoned with.

4. Preparatory to planting, determine the growth needs of the plant or tree selected and carefully prepare the soil to assure these conditions.

5. Devise a time schedule for planting and maintenance to assure the best start and continued growth of young plants and trees.

6. Provide adequate safeguards to protect newly planted areas.

7. Enlist the aid of the best informed and most widely experienced landscape architect available to assist in the selection of plant material, to formulate the design, and to develop a planting and maintenance schedule for these areas.

CHAPTER V

THE ORIENTATION OF OUTDOOR PHYSICAL EDUCATION FACILITIES

Outdoor physical education facilities should be arranged strategically in relation to the sun, the wind, shadows, and certain features of vital background areas. Because these facilities generally require considerable space which is very limited at most institutions, and because of factors other than orientation which must be considered when physical education facilities are designed, it is usually far easier to formulate standards for orientation than it is to apply them in actual practice. However, when it is possible to follow recommendations which are based on comprehensive analyses of activity requirements, important objectives for the design of outdoor physical education facilities may be realized.

Chapter V introduces the problems that should be considered by local planning groups desirous of determining the ideal orientation for physical education facilities. Included are recommendations useful in formulating decisions relative to the orientation of facilities for a select representative group of physical education activities.

Activity Analysis and Recommendations

The problems encountered when an attempt is made to arrange facilities for physical education activities in such a way as to provide the most advantageous conditions of play with respect to the sun, wind, and other factors of the physical environment are complicated ones. When considered in a general manner, it is desirable that they be simplified. For most purposes, this can be accomplished by classifying the selected activities under consideration into three main categories. One of these will consist of those activities for which a principal path of action can be described as occurring on a single axis and moving toward one end of such an axis. Included in this category are archery, rifle and pistol marksmanship, handball, track and field, ice skating, bowling, fly and bait casting, and golf. A second group will include those activities for which the principal action generally occurs on a single axis, but it may move alternately toward either end of the axis. Basketball; the tennis group, including badminton and volleyball; football, lacrosse, soccer, speedball, flickerball, field and ice hockey; and horseshoes and shuffleboard make up this group. The third group consists of two closely related activities (baseball and softball) for which a principal line of action can be described only when the elements of safety and functional necessity are carefully analyzed. The following section utilizes the possibilities for organization which result from the above classification, and affords the opportunity to introduce pertinent requirements of the specific activities and the recommendations which stem from them.

Group 1, Archery -- It is generally recommended that the archery range be located with its long axis due north and south and with the targets placed at the north end. With respect to the sun, this arrangement, for institutions located in the northern hemisphere, will provide the most ideal conditions of play if the activity is to be promoted throughout the day and during all seasons of the year. If this activity is to be engaged in most extensively during specific hours of the day and specific seasons of the year, however, it is necessary to provide information needed for determining a more specific standard. Such a standard should emphasize the importance of

designing the archery range so that the sun will shine from behind the archer, or well outside the effective range of his peripheral vision when facing the target. It should point out also the effect of a strong or persistent prevailing wind on the efficiency and comfort of the participants. If possible, the area should be shielded from such a wind, but since this is usually difficult to do, the prevailing wind should blow from behind the archer toward the target area in order to eliminate the hazard and discomfort of having dust blowing into participants' eyes. A wind which blows across the line of flight of the arrow will interfere appreciably with the accuracy attained. Needless to say, it is difficult to accomplish ideal conditions with respect to both sun and wind, and when this situation exists, it may be possible to utilize natural features of the landscape or to construct shelters or backstops to improve conditions for participation.

Group 1, Rifle and Pistol Marksmanship -- Rifle and pistol marksmanship, and also archery, present nearly identical problems relative to orientation. Consequently the above recommendations generally will hold true for these activities. While the wind has less effect on the accuracy of the rifle or pistol marksman than it does on the archer, it is more vital in the former activities that it blow from behind the shooter because of the burnt power which ought to be carried away from, rather than toward, the eys of the participant.

Group 1, Handball -- Because handball utilizes at least one wall which serves to protect the relati ely small court area from sun and wind alike, problems of orientation are greatly simplified for this activity. Probably the most bothersome feature centers around the problem of shadows over the playing surface. This is fundamentally a problem of brightness differences, and shadows which originate at the front or back of the court are much less bothersome than those which originate from either side. A court with the front wall at the east, therefore,would probably provide the best conditions for play during the greatest use-period.

Group 1, Track and Field -- Competitive requirements for track and field activities specify that performers should not be aided or hindered in their efforts by such a factor as strong wind. This is especially important wherever records of achievement are to be tabulated, and it is imperative where it may be desired to compare a performance with a national or world record.

While it is undesirable to have a straightaway arranged in such a way as to require runners to face the late afternoon sun, it is more important to eliminate the necessity for running with or against a strong wind. Since the running track is frequently designed to circumscribe the football field, and since orientation with respect to the sun is of more importance for football, planning the ideal for both activities is usually very difficult. When the long axis of the football field is at right angles with the late afternoon sun and the local prevailing wind, the ideal for both is assured. When the prevailing wind parallels the long axis of the football field, however, the functional requirements for championship competition in the dashes and hurdles would indicate the need for a second straightaway with a long axis perpendicular to the long axis of the football field and the wind. When the track is located within the football stadium, the straightaway is usually placed on the west side of the field so that spectators may observe a large portion of activity with the setting sun behind them.

For the field events, the same principles apply with respect to the wind, but for these activities the position of the sun assumes added importance. For the jumping events, it is important that the jumper be spared from the necessity of jumping into a head wind or directly into the sun, but championship requirements prohibit an arrangement which permits him to jump with a tail wind. For the shot put and the throwing

events, it is desirable to have the rays of the late afternoon sun and the direction of the prevailing wind cross the line of flight of the object projected at a 90 degree angle. When it appears necessary to have the sun at one end of the long axis, the object should be projected toward that end in order to decrease the possibility of hitting anyone who may lose sight of the object in the glare of the sun.

Group 1, Ice Skating -- The recommendations with respect to the wind are the same for ice skating as they are for track activities. In localities where the ice surface may be melted by the sun, however, it is desirable to protect the heavily used areas on the south from the sun's direct rays.

Group 1, Golf -- Whenever possible, facilities for golf should be arranged in such a way that the sun is behind the hitting area during the period of maximum use. For practice sand traps, it is desirable to have both the wind and the sun behind or on either side of the hitter during such periods.

Group II Activities -- The activities classified within this group -- basketball, football, lacrosse, soccer, speedball, flickerball, field and ice hockey, horseshoes, tennis, badminton, and volleyball -- are sufficiently similar to permit considering them together with respect to problems of orientation. For each of these activities, it is necessary that a principal line of action be accepted for the purpose of stipulating the best orientation for the area as a whole. Each activity in this group is played on a rectangular-shaped playing surface; the main objective of each sport is attained primarily through action on the long axis of the field or court; and the rules for each provide for equalization of the advantage which may be present for the team at one end of the area. For practical purposes, therefore, the long axes of these areas can be accepted as the principal line of action. When the sun's rays are at right angle to the long axes of these court and field areas during periods of principal usage, the most desirable conditions for play are assured.

It is also advantageous to consider the effect of prevailing winds on playing conditions when arranging facilities for these activities. The desirable solution is one in which these areas are effectively shielded from strong or persistent wind during the period of maximum usage. This is sometimes brought about by making use of natural barriers already in existence or by the strategic location of structures and landscape detail. Since it is difficult to protect large areas from existing climatic conditions, it is important to determine from which direction a wind will normally enter an activity area with the least amount of distraction to the activity. Here again it is recommended that when possible the long axis of the playing area be at right angles with the direction of the prevailing wind.

Group III, Baseball and Softball -- The basic problem confronted in prescribing the ideal orientation for baseball and softball is also one of determining the principal line of action. When one considers that a ball which is batted into fair territory may travel anywhere within the 90 degree arc formed by the foul lines, and that a ball may be thrown and received from any direction, it becomes apparent that it is impossible to provide ideal playing conditions for all participants and spectators alike. It is necessary, therefore, to determine which participants are in the most hazardous positions most frequently and to orient the playing area in such a way as to afford these players the best possible protection.

In these activities the batter, catcher and pitcher are most consistently in hazardous positions and should be given first consideration. The line through the center of the diamond extending from home plate through second base and into center field

is logically the most vital path of action in baseball and softball. Because the batter and catcher are on the receiving end of all pitches, they should receive maximum protection. However, since this line of action shifts so quickly when a fast pitched ball is hit sharply back through the diamond, players facing in both directions along this path are in potentially dangerous positions. These players must be protected from the necessity of looking directly into the sun. Brightness - difference created when shadows fall over the playing area and wind-blown dirt constitute other problems which require consideration.

Generally speaking, when the line formed between home plate, second base and center field is placed true north and south with home plate at the north end, the players most frequently in critically dangerous positions receive the maximum protection from the sun's rays. When home plate is located north of the pitcher's mound, the catcher, batter and first baseman receive the additional protection they need. In addition, spectators seated along the first base side of the diamond have the late afternoon sun to their backs, and infielders and outfielders have a minimum of interference from the sun's rays when watching fly balls. Under this arrangement, late afternoon shadows will enter the playing area from the right side of the diamond thus creating a brightness - difference problem. The elimination of tall trees near the right field foul line will minimize this problem.

A persistent and either dirt or smoke laden wind detracts from the efficiency of play and from the pure enjoyment of participants and spectators. However, arrangement with respect to the sun is more important insofar as attaining the objectives for planning these facilities is concerned.

The Sun and Functional Requirements

The functional problems encountered in arranging physical education facilities in such a way as to minimize the adverse effects of the sun on participants and observers have been introduced above. In order to understand this problem sufficiently to enable effective solutions, it is necessary to consider a few basic astronomical facts.

1. The sun reaches its highest altitude when it crosses the meridian of a place (noonday). At sunrise it is on the horizon somewhere within an arc about 60 degrees due east of a place and at sunset it is within the same arc due west. Accurate altitude angles of sun can be calculated for any specified time and place.[1]

2. In the temperate zone, the noonday sun in the summer is approximately 45^{o} higher than it is in the winter. During winter months the sun at noonday is considerably south of any spot in the United States, while in the summer months it is much closer to being directly above that place.

3. The arc of the sun's path in the summer is about 120 degrees longer than it is in the winter, i.e., the sun rises to the north of due east and sets to the north of due west in the summer, while it rises to the south of due east and sets to the south of due west in the winter.

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[1]See Diagram "Orientation Studies--Baseball", National Facilities Conference, Planning Facilities for Health, Physical Education, and Recreation, Rev. Ed., Chicago, The Athletic Institute, 1956, p. 38.

Naturally, the simplest way to determine the position of the sun at any time is to observe it at the time and place specified. When long-range planning methods are utilized, such information could be obtained prior to the time of urgent need and recorded in the building manual. This information can also be obtained by calculation. The mathematical methods used are those utilized by the navigator in determining the altitude and bearing of the sun. While this is ordinarily a problem for a navigator or engineer, the method used is described in Appendix B. The information and illustrations described should enable any mathematician to determine the azimuth and altitude of the sun for any locality and time.

On the basis of the above stated facts it is possible to generalize for purposes of developing gross standards to be used in the orientation of outdoor playing fields and courts. Figure 8 serves to locate the sun as it appears to move from its position at sunrise in the early morning, as it climbs overhead at high noon, and as it sets on the horizon to the west in the late afternoon.

Figure 8 points out that on the longest day of the year (June 21) the sun rises about 20 degrees north of due east and sets about 20 degrees north of due west. On December 21 the sun rises about 20 degrees south of due east and sets approximately 20 degrees south of due west. During the period between June 21 and December 21 the sun rises and sets at locations between the two extremes, rising and setting almost due east and west on March 21 and September 21. The illustrations emphasize the fact that for all-purpose fields and courts which are to be used during all hours of the day and during all seasons of the year, the placement of the principal path of action on the north-south line provides the best solution to the problems of orientation with respect to the sun. A sports area which is arranged to provide the best possible conditions of play in the late afternoon on June 21 would result in a maximum amount of glare for morning activity on June 21 or for late afternoon activity on December 21.

Because the sun hovers over the northern hemisphere south of a spot directly overhead (to a lesser extent in the summer than in the winter), players facing the north will always have some advantage when looking upward. Aside from this fact, play areas arranged with the principal path of action on a true north-south line generally will accommodate play in the best possible manner. For baseball, when home plate is located north of the pitcher's mound, the first baseman is favored during afternoon play, and the infielders and outfielders have the sun above and behind them during the middle of the day.

The Wind and Functional Standards

Those who direct, participate in, or observe outdoor sports activities are familiar with the effect of a strong and persistent wind from the standpoint of the enjoyment, comfort and efficiency of participants as well as of those who observe the performance. While it is frequently impossible to consider with equal weight all factors of the physical environment which should be taken into account when deciding on the best possible location and arrangement for facility units, never-the-less, an understanding of how each can affect the activity should be of value. Those who design physical education facilities should know what affect the wind has on the activities for which space is being planned, what arrangement will result in the least amount of interference, and what sources of information are available to determine accurately what wind conditions may be expected in the immediate locality during periods of use. The following section considers the latter problem.

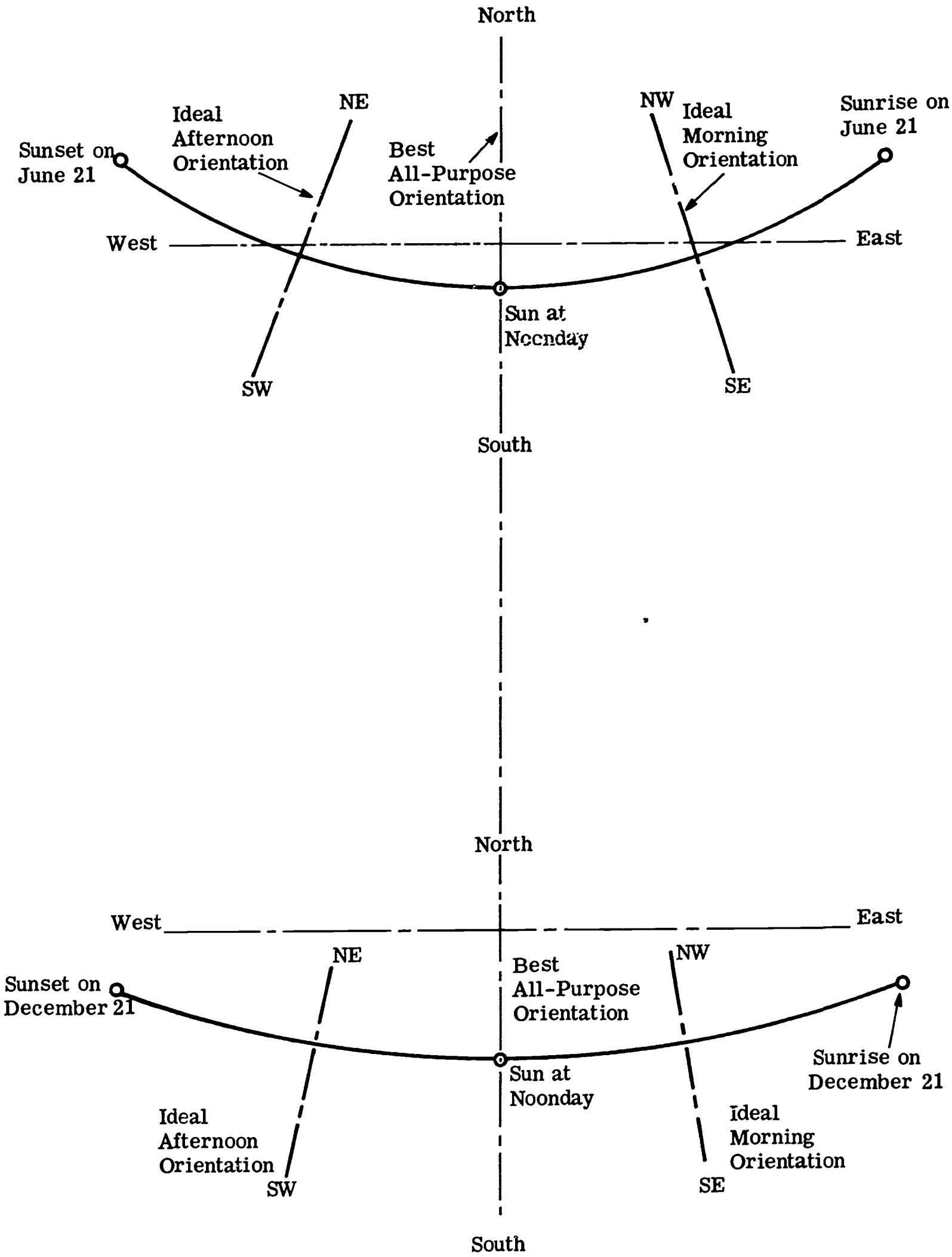

FIGURE 8. Orientation of Sun at different Seasons of the year

It has been emphasized above that pertinent information should be collected prior to the period of urgent need. The well-kept institutional and departmental building manual should provide information on conditions of the physical environment, and should include data on the direction and intensity of prevailing winds as seen at the contemplated site of development during periods of expected maximum use.

When this information has not been collected on a long-range basis, it is sometimes possible to obtain it from the United States Weather Bureau's Climatic Record. This publication is prepared and made available by the Weather Bureau, and contains pertinent information relative to observed conditions at each of the state weather stations. The statement below indicates the extent and content of the Climatic Record.

> The elements of the climate generally observed are not only those for the surface, but also those for the upper air, chiefly to the heights reached by airplanes. For surface conditions we have, obviously, the temperature (current, maximum, and minimum), the rainfall (amount, time, and type), the cloudiness and sunshine, and the wind direction and speed (average, maximum, and gustiness).[1]

When making use of the Climatic Record the following advice should be observed.

> The site of a proposed athletic field is not usually the site of a weather station. The nearest weather station may or may not have a climate closely like that of the field. If the weather station is at an airport it should be representative of other open flat areas within several miles, provided there is no special local influence owing to nearness of a large body of water or mountain. Before the record at a weather station is applied to the site of a field it would be well, therefore, to consult the local observer as to probable differences between his site and the field. It would also be wise to make observations at sunrise and at about 2:00 p. m. on clear days at the field, and compare them with the observations made at the same time at the weather station.[2]

The information obtained from the above sources may be used to considerable advantage in arranging physical education facilities and in devising landscape detail and structures to reduce the adverse effects of the wind. This information may also result in the formation of recommendations to alter current scheduling practices in order to take advantage of the most ideal conditions possible. For example, in many sections of the country prevailing winds are most persistent in the afternoon and, by comparison, are practically non-existent in the evening. A possible solution may be found in the use of floodlights and the scheduling of activities in the evening. Other solutions may depend upon a willingness to schedule certain activities during commonly regarded off-seasons of the year.

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[1]Charles F. Brooks, "The Climatic Record: Its Content, Limitations, and Geographic Value," Annals of the Association of American Geographers, September, 1948, p. 155.

[2]Letter from Charles F. Brooks, Director, Blue Hill Meteorological Observatory, Harvard University, July 29, 1950.

Other Factors to be Considered in Orientation

Among the other factors which should be considered, shadows and features of the background which affect the ability of participants to see clearly are the most important. This is especially true for activities such as tennis, baseball and softball, lacrosse, and ice hockey where the object to be seen is small and is projected with great speed.

Trees, walls, and other features which cause shadows to cross activity areas or appear in a vital background frequently interfere with the attainment of one or more of the important objectives for planning physical education facilities. Because of this, early consideration of the long-term results of such planting and construction is important. Those responsible for final plans should become familiar with program requirements in order that functional errors resulting from shadows and conflicting background colors may be avoided.

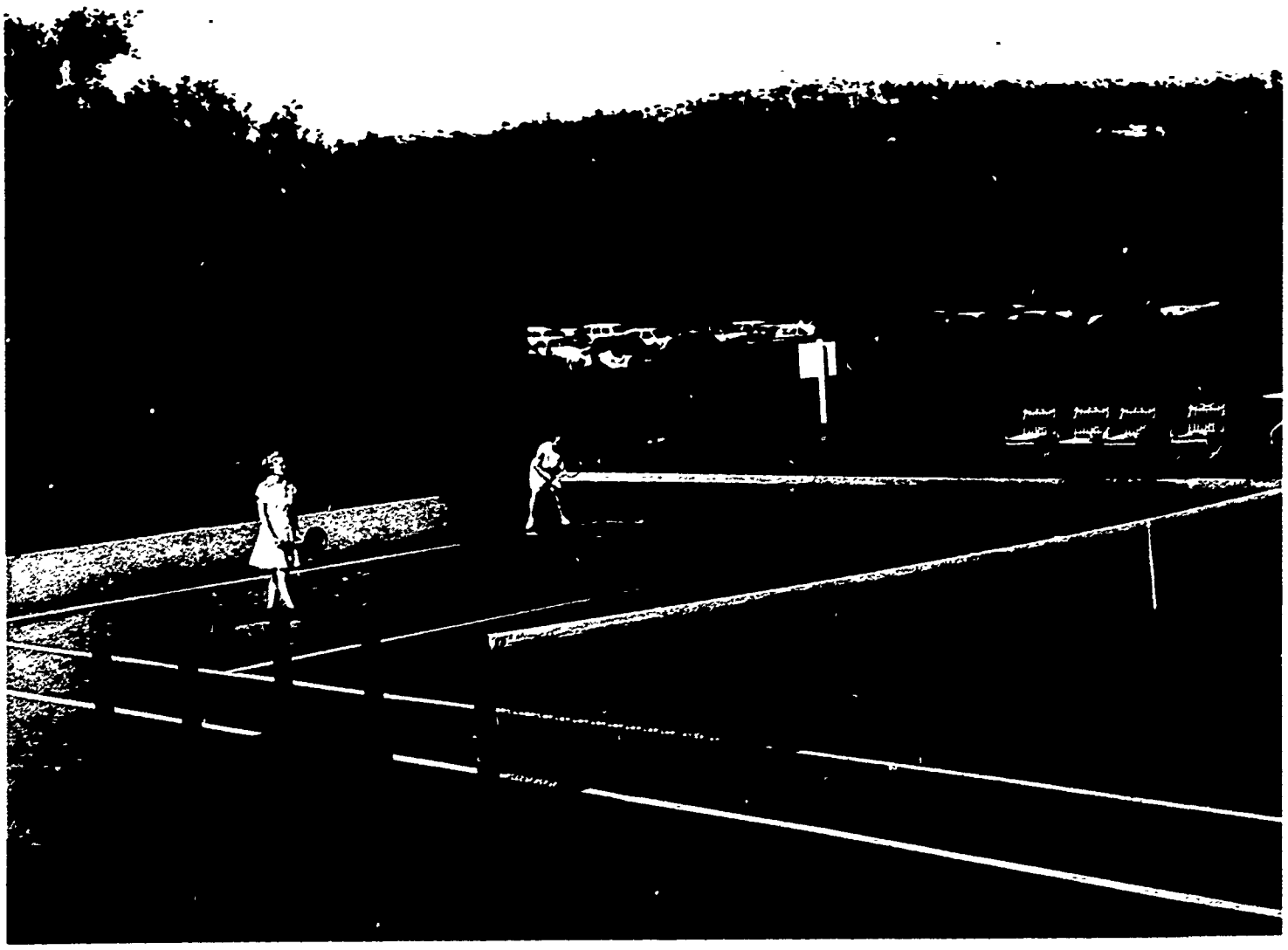

PLATE 8. VISUAL BACKGROUND AFFECTS EFFICIENCY OF RECREATIONAL ACTIVITIES. The above wall serves many functions. It serves as an enclosure to keep balls within playing area; it can be used as a hitting surface for practice of tennis strokes; and being consistent in color, it aids players in seeing the ball. Courtesy of American Bitumuls and Asphalt Company, San Francisco, California.

CHAPTER VI

PHYSICAL EDUCATION PLAY SURFACES

Playing surfaces utilized for outdoor physical education activities cover tremendous ranges in variety and quality. Included are natural earth surfaces which may be dusty, dirty, and completely and disgracefully inadequate, to specialized surfaces designed to provide the ultimate in functional and aesthetic desirability. In many instances the most desirable of specialized surfaces can be provided at nominal costs, while in other situations the total cost is quite substantial. In all situations, however, provision of the ideal surface for a specialized activity requires planning, work and financial outlay.

The selection and development of functionally superior playing surfaces for outdoor physical education facilities is a task which requires thorough consideration of activity requirements, a clear understanding of conditions under which they are to be used and maintained, and extensive knowledge of the availability and cost of the materials and labor required for their construction. Because of the diversity of conditions for which these surfaces are required, it is difficult to devise precise standards which are universally acceptable. Other difficulties originate because of the dearth of the controlled experimentation needed to objectively evaluate the worth of those surface types from which the selection must be made.

It isn't too difficult a task for the program specialist to describe a desirable surface for an activity with which he is familiar. Among the qualities which describe the ideal surface, those listed below are important.

1. It is easy to keep clean and is free of dust, loose particles, mud, and other materials which may be detrimental to the health, safety or comfort of those who use it.

2. It is smooth and firm underfoot, yet it is not unduly slippery when dry or wet, nor is it abrasive to the extent that uncalled for injury to person (or unnecessary wear or damage to equipment or clothing) results from contact with it.

3. It is of a color and texture which contributes to the appearance of the place while reducing unnecessary glare or heat absorption from the sun.

4. It is tough and resistant to wear so the necessity for maintenance, repair or replacement is minimized.

5. It is adaptable for efficient use under the climatic conditions to which it is subjected.

6. It is resilient, thus adding to the comfort and enjoyment of those who use it while reducing to a minimum the incidence of fatigue, strain or injury.

7. It possesses qualities which permit drainage down into the subsoil or which prevent water penetration while providing for its removal at the surface.

8. It is economical in both first cost and subsequent maintenance cost, and provides useful service over a long period of years.

Little imagination is required to see the difficulties involved in providing playing surfaces which compare favorably in all respects. In addition, because local resources and conditions of use differ, it is difficult to propose detailed recommendations for the development of these surfaces generally. As a result, the problem of selecting and developing outdoor physical education surfaces requires solution by local planners.

While it is probably unwise to attempt to define standards for the selection and preparation of outdoor surfaces, a pattern for action by local planning groups desirous of making intelligent long-term decisions with respect to this problem can be proposed. Such a pattern should include a comprehensive functional analysis of activity requirements, a thorough study of the local conditions to be encountered in normal usage, and a study of the qualities and the records of use of all potential surfaces and surfacing materials preparatory to making selections.

Analysis of Activity Requirements

The final worth of a surface is judged by the extent to which it serves the program for which it is selected. Therefore, initial consideration should take into account the specific nature of the activities to be conducted on a particular surface. It is an important responsibility of the program specialist to provide detailed functional analyses of all activities to be promoted on physical education surfaces. Such analyses should include the fundamental nature of these activities and the basic qualities needed in surfaces to promote them most effectively and safely; local scheduling practices which might indicate the need for providing qualities needed for multiple-use of the surfaces; specific stipulations for surfaces which result from athletic conference requirements or recommendations; and other significant details which are important in contributing to the utility and functional validity of physical education surfaces.

While many of these factors may be unique with a particular program, others can be stated for the profession generally. The following functional analyses of selected physical education activities fall in the latter category.

Archery - Rifle and Pistol Marksmanship -- While the outstanding features of these activities reveal few clues as to the importance of any specified surface, when factors of safety, protection of equipment and aesthetic requirements are considered, definite qualities can be stipulated. For efficient performance (as well as for reasons of health and safety) a ground cover should effectively aid in keeping dust, dirt and debris out of the air and out of the eyes of performers. Such a ground cover should be soft and non-abrasive in order to minimize damage to arrows and decrease the danger of ricocheting bullets, and it should be of a color and texture which reduces glare from the sun while adding to the appearance of the place. Footpaths should be constructed between parking areas and shooting points, and between shooting points and target areas.

Baseball - Softball -- A surface for baseball or softball should permit the safe, sure and speedy movement of participants; it should be non-abrasive, resilient,

and free of rocks and other objects dangerous to a running, falling or sliding participant; it should be smooth and uniform in texture so that a rolling or bouncing ball will respond in a consistent manner; it should be firm, yet resilient enough to assure against excessive bouncing of, or damage to the ball on contact; it should be clean and free of dust and other debris which detract from the efficient vision and comfort of participants and spectators; heavily used areas around players' benches, catcher's, batter's, and pitcher's boxes, and in the basepaths should be of a material which is firm, yet which also can be worked easily and quickly; and it should be attractive in appearance and texture. In addition, it is important that it encourage drainage in order that the facility may be usable early in the spring and soon after a rainfall.

Basketball - Handball - Tennis -- These are activities which require a considerable amount of quick starting, stopping and changing of direction on the part of participants, and a true and uniform bounce of the ball. Surfaces for these activities should be clean, firm and free from glare; they should be resistent to wear; they should be smooth and non-abrasive, yet should assure true and uniform footing and a minimum of injury to participants or damage to ball or other equipment on contact; they should be resilient in order to minimize strain and fatigue in those who use them; and they should minimize heat absorption from the sun.

Football - Lacrosse - Soccer - Speedball - Field Hockey - Flickerball -- These sports require a great amount of activity on the part of participants and involve considerable falling resulting from planned or unavoidable contact. Inasmuch as such activity is dispersed over a large area, the surface need not be as resistant to wear as those for other sports which take place on smaller spaces. The surface should be level and free from dangerous objects which may cause injury to participants or damage to equipment; firm to resist wear and permit speed of action, yet resilient to minimize injury to falling participants; and it should facilitate drainage in order to assure the maximum amount of usage.

Golf -- Golf instruction should be conducted on surfaces which are as similar as possible to actual conditions found on the golf course. Surface areas which simulate fairways, tees, sand traps, and putting greens are necessary if the instructional program is to be meaningful. These surfaces should be such as to yield to a club head in fast motion without causing damage to the club, they should be hardy and durable to survive rough usage, and they should be large enough to eliminate the necessity for crowding in confined spaces. Putting surfaces should be smooth and large enough to provide some level and some rolling spaces for practice of various putts.

Horseshoes -- The most important functional surfaces of a horseshoe court are the 6-foot square areas in which the stakes are placed. These surfaces should be be level and of a moist or putty-like texture in order that the shoes will not bounce or skid when thrown properly, and so the surface will not be chipped or chewed by the falling shoes. It is desirable that a 3-foot-wide footpath be provided between stakes and extend around the outside of the pitchers' boxes.

Ice Hockey - Skating -- Surfaces designed as multiple-use areas, and which are to be used for ice formation during cold seasons, should be light in color so that the minimum amount of heat absorption from the sun is effected. They should be water resistant, though this is unnecessary in colder regions, and they should be graded in such a way that drainage may be easily controlled.

Track and Field -- Because of the diversity in track and field activities, various types of surfaces are needed. The running track should be firm and "fast", resilient, level and smooth, durable, non-abrasive, and clean. In addition, it should permit easy penetration by spiked shoes and provide for quick and efficient drainage of surface water into the subsurface. The running track surface should possess bonding and filler materials in proper proportions to permit ease of maintenance. Approaches for the jumping events should have the same qualities as those for the running track, but because these areas receive more concentrated usage, qualities of durability are more important and should be combined with those which provide sure and fast footing. Landing pits for these events should be very resilient in order to absorb some of the shock of hard landings, yet there should be some firmness (especially for the broad jump) in order to assure reasonably stable footing while landing. The weight and throwing events require a throwing circle surface which is firm and durable, smooth, and sure underfoot. These events also require a landing area for the object thrown which will possess qualities of resiliency, firmness and durability.

Volleyball - Badminton -- Volleyball and badminton are activities which can be played on a wide variety of surfaces, yet for maximum attainment and enjoyment a surface which is smooth, firm and consistently true underfoot is necessary. This surface should be durable, yet resilient; it should be clean and attractive in appearance; and it should minimize glare and heat absorption from the sun.

Surfaces and Local Conditions

The selection of outdoor physical education surfaces should be based on an understanding of the conditions found at the locality in which they are to be constructed and used. Many surfaces which would be functionally efficient and economical in one locality may prove to be expensive and entirely unsuitable in another. Among the common factors which should be studied by those responsible for selecting a local surface are (1) climatic conditions, including extremes in temperature and rainfall; (2) the type of surface and subsurface soil which exists; (3) the availability and cost of materials needed in construction; (4) the availability and cost of the labor and supervision required for construction and maintenance; and (5) the habits and traditions of the people in the area which determine to a large extent their willingness to accept a particular type of surface.

Climatic Conditions -- Local climatic conditions provide important clues to the possible usefulness of various surfaces. These conditions are important also in formulating specifications for the type of surface selected. This is especially true with respect to extreme or prolonged heat, cold, rainfall, or snowfall. Because of these factors, it is sometimes necessary to compromise an activity requirement somewhat in order to develop a surface which will prove most efficient for use in the climate which prevails. Climatic conditions also may necessitate the formulation of rigid specifications for surface and subsurface construction at considerable added expense, or they may indicate the practicability of little subsurface preparation and comparatively light surface courses.

Soil Conditions -- The desirability and adaptability of the surface and the subsurface soil for improvement should be studied. While natural earth surfaces usually are not highly desirable for physical education activities, the soil found on a site may be adapted and improved with satisfactory results when especially ideal conditions prevail. Under less ideal conditions it may be necessary to remove and replace considerable soil before a desired surface can be developed satisfactorily.

Availability and Cost of Surfacing Materials -- The type of surface selected, and the methods of construction used should take into account the availability and the cost of the materials needed. By way of illustration, rock asphalt as a surfacing material has been widely acclaimed in some regions. However, it would be an expensive undertaking to transport the amount of natural rock asphalt needed to construct a large surface if the distance from its original source to the site of its intended use were far. It is important that the materials required for the development of a desired surface be readily available, otherwise the selection may be an expensive and impractical one.

Availability and Cost of Labor -- Inasmuch as both first cost and maintenance costs must be considered when determining the desirability of a surface, and since the cost of labor and supervisory personnel is high in each, economy and efficiency dictate that the availability and cost of the kind of labor and supervisory assistance required be determined prior to a final selection. Where labor costs are high, it may be advisable to select a surface which will be high in first cost but which will require a minimum of maintenance over a maximum period of useful service. In like manner, the excellence of most surfaces is closely related to the degree of accuracy and thoroughness with which specifications are formulated and followed in construction procedures. Therefore, it is important that competent personnel be available to draw up specifications, supervise construction and do the work required skillfully and quickly.

Habits and Traditions of the People -- Efficient administration requires that important decisions be based on merit. However, since the final acceptability of a surface is frequently determined by the people who are to use it, their habits and traditions and their likes and dislikes should receive consideration when the original selection is made. Inasmuch as the attitudes of people are determined by what they are accustomed to or what they know about a subject at the moment, strict adherence to their wishes at times may retard progress. It is necessary, therefore, for leaders to know about quality materials and up-to-date practices and to emphasize their importance. This is as much a responsibility of those who plan physical education facilities as it is for those who strive for progress in any other area of endeavor.

Description and Appraisal of Surfaces and Surface Materials

In different parts of the country many varieties of surfaces have been designed, constructed and placed in service. Many of these are adaptations resulting from peculiarities of materials and conditions found in the different localities and they may serve a specific program admirably. In actual practice, however, those who are responsible for selecting surfaces for outdoor physical education facilities may choose from a strictly limited number of possible surface types. This fact simplifies the problem from the standpoint of the program specialist and the administrator. However, since wide variations and degrees of acceptability do exist, the responsibility for providing a surface which will contribute to the program economically and efficiently over a maximum period of time does not end just with the selection of the surface type.

The formulation of specifications for the improvement or construction of a specialized surface is basically an engineering function. The selection of the engineer who will provide the specialized leadership needed to ascertain and utilize the facts applicable to the situation and to develop specifications is of major significance.

Natural Earth -- Natural earth surfaces are those for which little or no improvements or alterations are undertaken. The original surface found on the site may be graded, rolled and immediately put to use in the program.

It is usually a temptation for institution officials to encourage the expediency and apparent savings which result when playfields of natural earth are developed. When true, long-range economy is considered, however, real savings seldom result from such quick decisions. As a matter of fact, it is an unusual soil which readily lends itself to efficient use and maintenance for many of the activities in the modern physical education program. On the other hand, persons who are experienced in soil improvement methods sometimes can suggest adaptations to the soil found on a site that result in an economical acceptable surface for specialized activities.

Silt - Sand - Clay -- Soils are classified on the basis of particle size, composition or consistency. The chemical and physical properties of the soil determine its specific usefulness. Sands are made up of particles of stone of varying sizes and are loose and granular in texture. Silts may consist of small particles of the same mineral composition as those found in sands, or they may be the product of chemical decay. Clays contain the chemically reactive portions of the soil, and when they are wet they may form true pastes which harden into compact masses upon drying. When clays, sands and silts are combined, loams result. When a loam contains considerable sand, but enough silt and clay to make it cohesive, the soil may be classified as a sandy-loam. If sand is added to a heavy soil, the resulting mixture becomes less plastic, more resilient, and easier to work. Sand also may be added to some of the lighter surfacing materials such as sawdust and tanbark. This addition will improve the stability of these materials while reducing their resiliency very little. When clays are added, the surface becomes more stable and plastic.

All of these materials are important in the development of surfaces for specialized activities. Clays traditionally have been employed in the construction of clay and quick-drying tennis courts, cinder running tracks and approach lanes for field events, the heavily-used "skinned" areas of the baseball and softball diamond, and for horseshoe pits. Sandy-loam soil is referred to constantly in the development of athletic turf. Sand is important in the improvement of soil to increase its drainage potential and decrease its plasticity, and also as aggregate material for cements, bitumens and clays. These materials usually are available, and when they are utilized properly and in proper proportions, they are useful in the development of physical education surfaces.

Graded Cinders -- Cinders are formed when coal is burned, and they provide an excellent material for use in developing certain specialized surfaces. They are screened to the size desired, and while they are less stable than long-term specifications demand, nevertheless, they are a valuable surface ingredient.

During the years when the railroads maintained steam engines exclusively, and steam in other industries was the major source of power, coal cinders were a cheap and easily-obtained material. Since they were porous and moderately stable, they were used mostly in the construction of subsurfaces where resiliency and drainage were required. A finely graded (1/4 inch to 3/8 inch) clean, head-end steam cinder nearly always has been desired for the construction of the running track and wherever a fast but resilient surface was needed and abrasiveness was not exceedingly detrimental. Today it is becoming increasingly difficult to obtain this material in a desirable condition, but manufacturers of cinder blocks have cinders in a desirable

form for this use. The adaptation of other materials for these uses may become necessary in the future. With the advent of the use of pumice and perlite, acceptable substitutes are becoming available. These materials are porous, clean, and relatively stable, and they should prove excellent for the construction of this kind of surface. Brick dust is another increasingly used substitute.

Crushed Stone -- Stone which is quarried, crushed to the size desired, graded, and washed is referred to as crushed stone. Because crushed stone is readily available, stable and clean, it is a valuable material for the development of some surfaces. Since it is non-resilient and possesses sharp edges, it is seldom used except as aggregate material for bituminous and cement concrete, as backfill material for open-type drainage ditches, as a surface border around fixtures and outer edges of facility areas, and for roadways and footpaths.

Tanbark - Sawdust -- Tanbark is the bark from trees, such as the oak or hemlock, which contains large quantities of tannin. Tanbark in this form is used in tanning leather. Spent tanbark - as used in circus arenas, race tracks, jumping pits, and under various apparatus - is the spent bark removed from the tan vats. Spent tanbark resembles coarse shavings and is resilient and pliable. Sawdust and wood shavings are waste by-products of the sawmill and are also soft and resilient.

Either of these products is useful when mixed with sand in the proper proportion and confined to special use areas such as under apparatus and in jumping pits. Decomposed sawdust from wood other than pine may also be used for soil improvement preparatory to the development of turf.

Turf -- Turf, when used to describe a specific surface for physical education activities, refers to a ground cover which includes a grass and its root system. Together, these form a surface mat. When the soil is prepared properly; when a species of grass is selected which thrives in the climate and under the conditions of use to which it is to be exposed; and when proper conditions of growth are provided, a surface can be developed which is aesthetically attractive and functionally useful. Grass for physical education facilities should have a dense, fine-leafed stalk which will resist damage and propagate itself under adverse conditions of growth. It should also be capable of quickly developing a deep root system as an additional safeguard to its existence.

Turf, when properly selected, established and maintained, has no practical equal as a surface for field games and landscape areas. While the cost of developing and maintaining this type of surface places it among the most expensive, the contribution which it makes to the functional needs of the program and to aesthetic values requires that it be adopted for many activities whenever the expense can be justified and met. Because of the difficulty of maintaining a healthy turf, its use should be confined to large areas and for activities which do not require concentrated use. It is necessary also that off-seasons be provided for the rest and rejuvenation of the grass, and that other all-weather surfaces be provided for use during wet seasons or while the ground is thawing.

While turf is somewhat slippery underfoot, and especially so when wet, the use of shoes equipped with cleats or spikes nullifies this disadvantage and makes of this surface one which is resilient, non-abrasive, attractive, safe, clean, and relatively fast.

Because of the variance in soil and climatic conditions in different parts of the country, the selection of a grass variety and the development of a sturdy and attractive turf is a task which requires the assistance of a specialist.

> Local soil and climatic conditions will govern the composition of the seed mixture to be planted and the rates and dates of seeding. The most desirable grasses are those that are adapted to local conditions; that can form a dense sod; resist wear, heavy use and abuse, and drought; recover quickly after periods of hard use; bear heavy loads; require relatively low fertility; and be maintained easily and inexpensively.[1]

Assistance is readily available at state agricultural experiment stations. These agencies are prepared to make soil tests, to recommend a species of grass best suited to specific conditions, and to propose a schedule for turf development, including planting, fertilization and maintenance.

Stabilized Soil --Soils can be stabilized by the use of rosins, salts, cements, or bituminous materials. By careful analysis of existing soil conditions, wise selection of the kind and amount of stabilizing agent, and careful workmanship in construction, a surface can be developed which is firm and durable, smooth, clean and economical.

Natural soils have been stabilized successfully for use on highways and air strips. The possibilities for utilizing the methods employed by highway departments and aeronautical groups seem promising - especially in the development of base courses. Several desirable surface finishing materials are available for application over such a base, and the combination should produce highly satisfactory results. Because of the nature of the problems which must be solved if soil stabilization is to prove successful for physical education surfaces over a long period of time, it seems advisable to recommend this method only when highly skilled and experienced personnel are available. Proper soil stabilization requires a complete and accurate analysis of the soil together with careful experimentation to determine the exact proportions of aggregates and stabilizing materials needed. The actual work of preparing the surface must be supervised carefully to assure the complete mixing, proper drying, and thorough compactness of all materials.[2]

Cement Concrete -- Cement concrete is a surface material in which aggregates of various texture are bound together with hydraulic cement. This type of concrete varies in abrasiveness, depending upon the size of aggregate used, but its extreme hard surfaces and durability are characteristic.

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[1]Ralph H. Morrish, Alton E. Rabbitt, and Edward B. Cale, "Airfields and Flight Strips," Grass, The Yearbook of Agriculture, Washington, Government Printing Office, 1948, p. 319.

[2]National Recreation Association, Surfacing Playground Areas - A Supplement, M. P. No. 219, New York; The Association, 1948, pp. 1-2. (Note: Additional information is available from the Portland Cement Association, 347 Madison Avenue, New York, N. Y.; The Asphalt Institute, 801 Second Avenue, New York, N. Y.; The International Salt Company, Inc., Ithaca, New York; from various city, county and state highway departments; and from experienced surfacing contractors.)

Cement concrete has been used for court surfaces, sidewalks and roadways, and wherever maximum permanence, durability and extremely hard surfaces are desired. Its advantages include year-round utility, minimum maintenance expenses and a smooth surface which can be permanently colored. Its disadvantages lie in the complete lack of resiliency, the high cost of construction - as well as the difficulty of making repairs when they are needed - and the necessity for expansion joints in other than small surface areas. When cement concrete surfaces are constructed to specifications which are suitable to the conditions of use for which desired and to local soil and climatic conditions, long and practically trouble-free performance can be expected.

Bituminous Concrete -- Bituminous concrete is a surface material in which aggregates of varying texture are bound together by the use of bitumens. Since bitumens are somewhat plastic, when aggregates are selected which are highly resilient (e.g., ground cork, rubber or sawdust), the surface assumes some of the qualities of the aggregate.

Bituminous materials, when properly selected and utilized, permit the development of playing surfaces which may be cheaper in construction cost than cement concrete, are easily maintained and repaired, and will provide long periods of usefulness. This surfacing material can be developed to meet the specifications for durability desired; permanent lines can be applied, color can be added, and near maximum utility can be expected. Limitations center mainly in the belief that this type surface becomes soft and sticky in the summer. With the proper grade of asphalt cement specified, bituminous concrete should not become sticky or objectionably soft in midsummer. A second objection centers around the belief that these products are heat-absorbent. This objection, however, can be made for any surface which is dark in color. When the surface course is made lighter in color by the addition of color pigments, this objection can be minimized.

Recommendations for Physical Education Surfaces

When local planning groups utilize a pattern of action which includes an analysis of activity requirements preparatory to specifying the qualities desired in physical education surfaces, a study of local conditions under which they are to be used, and a study of the availability and cost of the materials and labor involved in construction, it will be revealed that considerable time, effort and expense are involved. In addition to the information obtained through the above procedures, it is important that a detailed study be conducted of the desirability of various surfaces in use at neighboring institutions.

By studying practices on a local, state, regional and national scale, new inventions and desirable procedures may become better known and the time-lag between invention and widespread acceptance can be shortened appreciably. Modern practices are uncovered in literature, by special inquiry, and by visiting others who are utilizing them. The recommendations included in the following section should not be accepted as substitutes for the painstaking task of fact-finding at the local level. Instead, they should be utilized to supplement specific local information and perhaps to serve as a starting point for locating more advanced and pertinent facts.

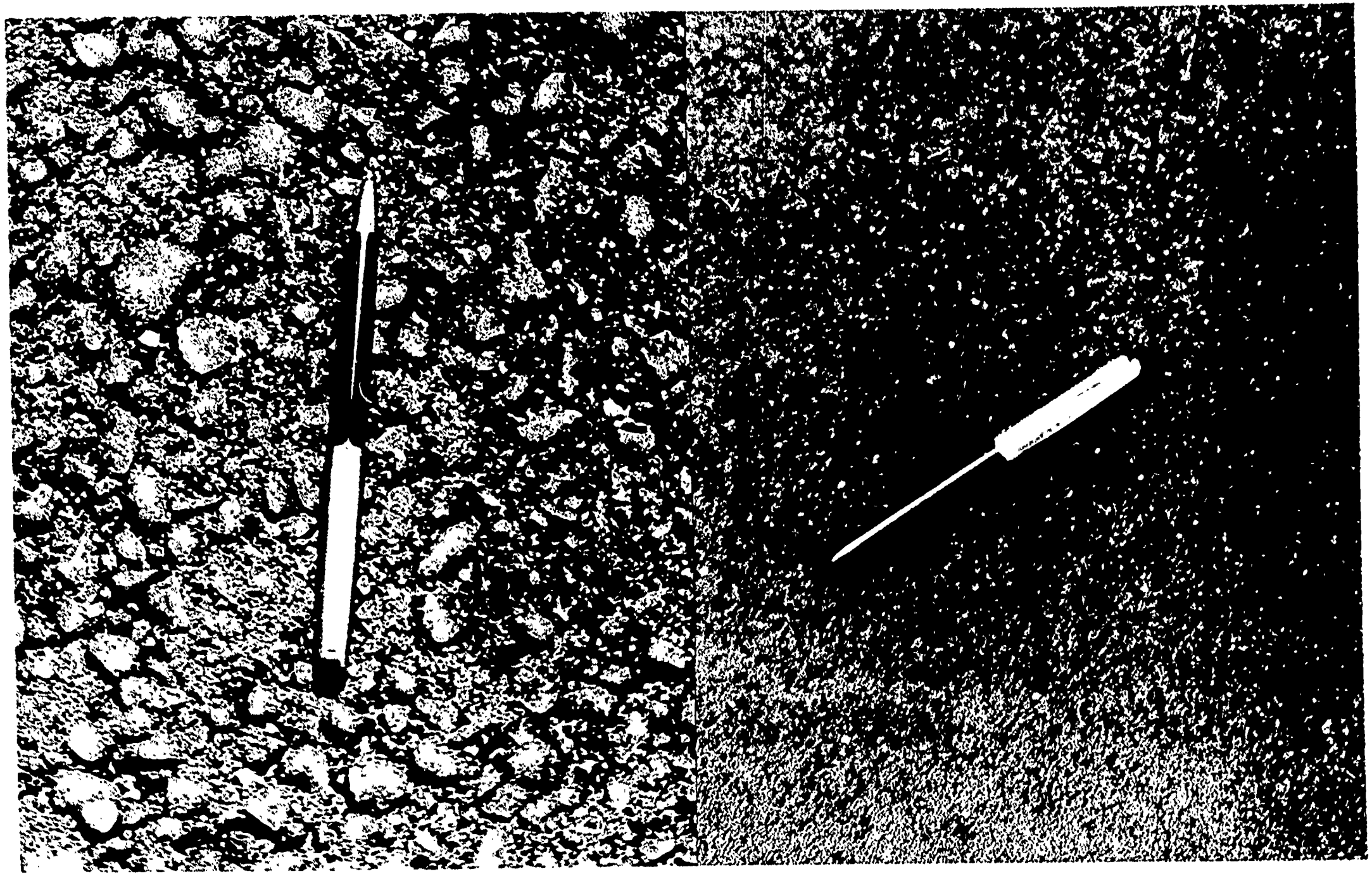

PLATE 9. BLACKTOP COMES OF AGE. Note difference in texture of the old and the new asphalt and bituminous surfacing. Permanent red or green surface coloring and special asphalt base aluminum paint for installing court lines provide a functionally pleasing surface. Courtesy of American Bitumuls and Asphalt Company, San Francisco, California.

It is difficult to evaluate a practice or a commodity unless controls can be established to validate the information obtained. Most of the evaluative information available on surfaces is based on subjective data. There are few surface plots in existence which can be used for making comparisons under experimental conditions. In the face of this deficiency, less objective methods of evaluation must be employed.

Table 5 suggests one method for evaluating physical education surfaces. This information was obtained from school business managers in the United States and Canada.

TABLE 5

A RATING METHOD FOR PHYSICAL EDUCATION SURFACES[1]

Criterion	Ideal	Earth	Turf	Sand	Crushed Rock	Bituminous	Concrete
First Cost - Cheapness	1	1	4	2	3	5	6
Maintenance - Cheapness	1	4	6	3	5	2	1
Durability	1	5	6	3	4	2	1
Resilience	1	2	1	4	5	3	6
Non-Abrasiveness	1	3	1	4	6	2	5
Firmness	1	4	5	3	6	2	1
Freedom from Dust	1	6	3	5	4	1	2
Cleanliness	1	6	3	4	5	2	1
Smoothness	1	5	3	4	6	1	2
Good Drainage	1	6	4	5	3	2	1
Utility	1	4	2	3	6	1	5
Good Appearance	1	6	1	4	5	2	3
Acceptability	1	4	1	3	6	2	5
	13	56	40	47	64	27	39

[1]National Association of Public School Business Officials, Playground Surfacing, Bulletin No. 7, Evanston, Illinois: The Association, 1940, p. 39.

By utilizing this method of evaluation at the local level, it is possible to compare the merits of the surface types under consideration in light of the specific qualities stipulated for the surface desired.

General recommendations for physical education surfaces have a limited usefulness. Nevertheless, on the basis of what is known about activity requirements, conditions under which activities are normally most efficiently conducted, and the usefulness of various surfaces, the following recommendations are offered.

Archery - Rifle and Pistol -- A turf surface is most desirable for archery, but where this is impractical, a surface of natural earth which can be treated to reduce the prevalence of dust in the air may be acceptable. Footpaths of finely crushed stone, sand-clay-cinders, or local materials should be provided.

Baseball - Softball -- Turf is the ideal surface for baseball and softball. The heavily used "skinned areas"--including the pitcher's mound, the batter's and catcher's boxes, basepaths, on-deck batter's circles, and dugout areas - should be surfaced with improved natural earth. While local experimentation is required to determine the exact proportions of available bonding and filler materials needed to provide the best surface for these specialized areas, soils which consist of about 60 to 70 per cent loam to which has been added clean, sharp sand, should come close to doing the job.

Court Activities -- Bituminous concrete or cement concrete provide preferred all-weather surfaces. The choice to make between the two is a difficult one. Each possess advantages as well as disadvantages. When designed and constructed to proper specifications, either of these surface types will provide excellent low-maintenance service.

Field Activities -- There is no surface which equals turf for the field activities. Because even the most rugged and adaptable grass will not stand up to hard daily use, however, provisions must be made to prevent turf areas from being over used. This can be accomplished by scheduling activities on different turf areas to permit the proper rejuvenation and maintenance of the grass. It can be done also by alternating activities between turf areas and all-weather surfaces. Natural earth surfaces are usually inadequate substitutes for turf areas. When no other course is available, however, such a surface can be treated to decrease dust problems and altered to provide adequate drainage and to decrease maintenance complications.

Golf -- There is no adequate substitute for turf tees and fairways, grass putting greens, and traps of loose, clean, granular sand. Where room for spacious grass practice tees is very limited, rubber mats may be substituted, but this does not provide desirable or realistic practice conditions.

Horseshoes -- The pitchers' boxes should be of potters' clay maintained in a moist or putty-like condition. The footpaths between boxes should be of crushed stone,or a mixture of loam or clay with crushed cinders, pumice or perlite, or a composition of local natural materials.

Ice Hockey - Skating -- In regions where the temperature remains low enough, ice can be formed on nearly any surface including natural earth, clay, turf, and cement or bituminous concrete. If the surface is light in color, a minimum amount of heat absorption from the sun is effected and ice is formed most readily.

Tennis -- For normal institutional use, a superior grade of bituminous or cement concrete provides the best low-maintenance, all-weather surface for tennis. Where weather and maintenance costs are not problems, the patented "quick-drying" surfaces are recommended as the best of the clay-type surfaces.

Track and Field -- The running track should have a surface course from 4 to 6 inches deep composed of a mixture of clay or loam with finely ground cinders, crushed shell or brick, pumice, perlite or some such local material. The proportions to be used should be determined after the materials have been analyzed and experiments with them have been conducted. The field event runways should be of a similar construction, but the addition of a small quantity of portland cement to these surfaces will increase their durability. The shot, hammer and discus circles should be considerably more stable than runway and track surfaces. At Dartmouth College, cement concrete circles have been used,[1] and at Yale University[2] (and elsewhere) stabilized earth surfaces have been developed. The landing areas for the weight events may be of natural earth, and for the discus and javelin throws they may be of turf. When a small amount of portland cement is sprinkled on the shot-put landing area, a harder surface results and competitors are given the maximum credit for their efforts. Jumping pits should be back-filled with sawdust which has been sifted to remove splinters and mixed with fine sand or loose soil to improve stability. Depths should range from about 18 inches for the high jump and broad jump to 24 inches or more for the pole vault when a false bottom of plank is provided at that depth.

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[1] Thomas E. Jones, How To Build A Track, University of Wisconsin Estension Division, 1955, p. 42.

[2] Ibid., p. 41.

CHAPTER VII

SPORTSLIGHTING

Educational institutions and other agencies which sponsor recreational programs are confronted with the necessity for providing physical education facilities for a rapidly increasing number of users. For most organizations it is necessary to provide either additional facilities or to adopt all acceptable means for utilizing these facilities to their maximum capacity. Increased use is possible when outdoor physical education areas are equipped with floodlights for night-time use and this often is a feasible and economical means of aiding in the solution of this perplexing problem.

Since about 1930 when sportslighting first came into practical use,[1] the possibilities for enriching physical education programs by the utilization of floodlights have stimulated the imagination of administrators in physical education and recreation. By 1940 there were 2000 lighted sports areas in the United States[2] and the number of installations has increased steadily since then.[3]

During recent years, the quality of equipment available for sportslighting has improved and technical understanding of the problems involved in providing the amount and kind of light required has evolved to the extent that it is now possible to provide excellent conditions of play by utilizing electricity and modern floodlight equipment.

Among the advantages which can be realized by efficient utilization of floodlights, the following are significant.

1. Educational institutions faced with problems of expanding curricula and increased student enrollments are finding it difficult to schedule all of their required and elective courses within the time limits of the traditional school day. It is necessary, therefore, that the physical educational program be conducted during daylight and evening hours in order that maximum educational opportunities may be made available to all students.

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[1]Ralph H. Gardner, "Football Sees the Light," Scholastic Coach, January, 1949, p. 7., and R. J. Swackhamer, "Lighting Outdoor Sports," Reprinted from General Electric Review, July, 1945 (rev. April, 1947), p. 2.

[2]Glenn G. Bobst, "Planning for the Future," Recreation, February, 1940, p. 611.

[3]"Does Floodlighting Pay?", Scholastic Coach, January, 1950, p. 44., and "Lighting of Outdoor Recreation Facilities," Recreation, February, 1938, p. 66.

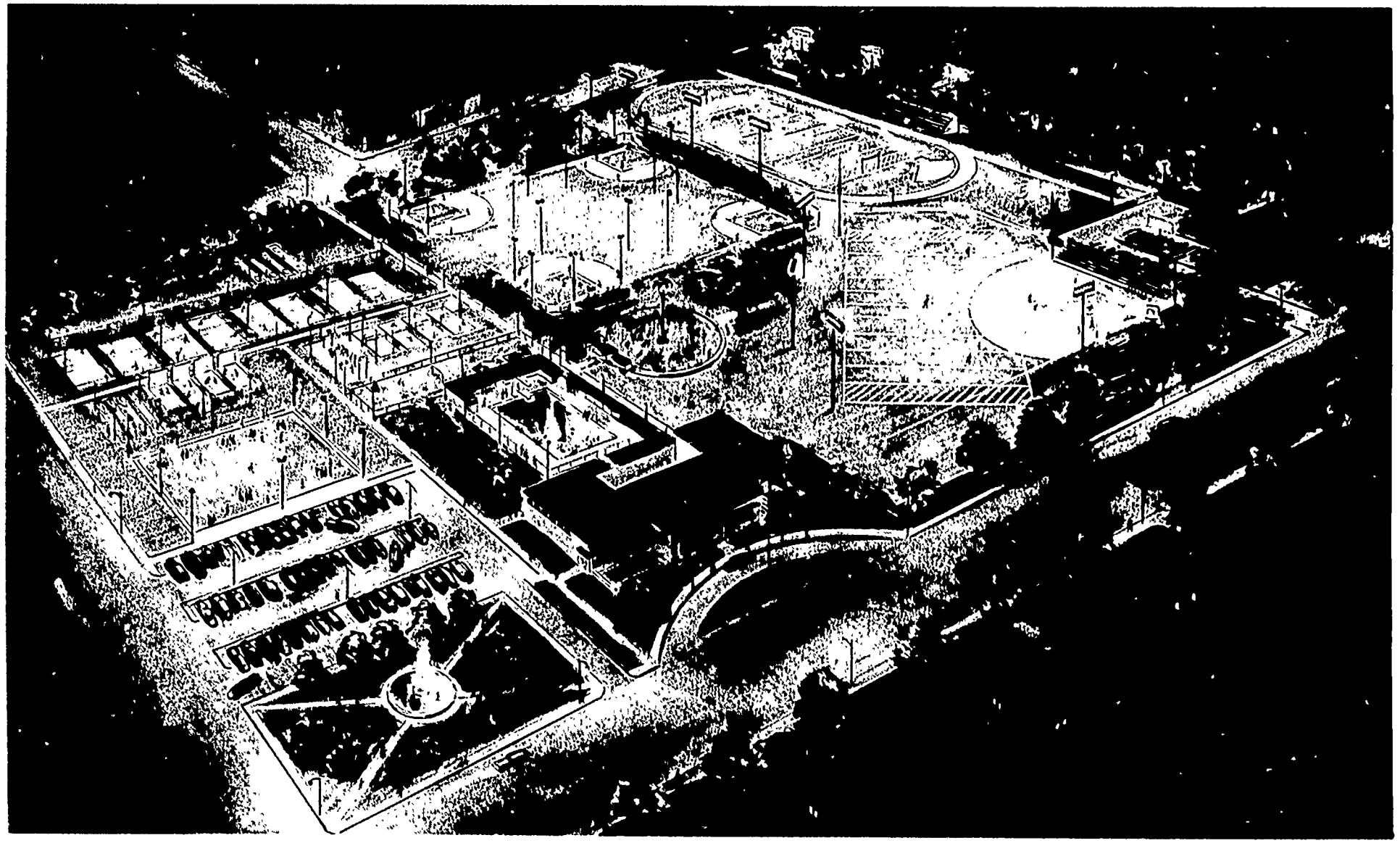

PLATE 10. ARTIST'S CONCEPTION OF FLOODLIGHTED MODEL RECREATION CENTER. Courtesy of General Electric Company.

2. Educational institutions, where rich and interesting programs of physical education are provided, are finding it increasingly difficult to provide enough facilities to meet the increased demand for them. By making existing facilities usable during a greater portion of the day and night, these institutions may completely or partially solve their problems. Sportslighting is a feasible and economical means of increasing the utility of physical education facilities.

3. Lighting of outdoor sports areas in many communities is necessary in order to take advantage of the most ideal playing conditions. In many localities high temperature, rain and wind are frequently more prevalent during daylight hours than they are after dark.

4. Sportslighting enables greater flexibility in scheduling athletic contests. Because of this, sportslighting provides an effective means of accommodating administrators, coaches, participants, and spectators alike. Greater attendance and increased revenue are the more easily measured results, but increased good will is an additional valuable gain.

Problems of Outdoor Lighting

The problems encountered in planning and installing floodlight systems for outdoor physical education activities vary with the activity and with the individual situation. However, there are basic considerations which should prove helpful to those responsible for planning facilities which include these installations. Among these, the fundamental concepts of all illuminating problems and the specific complexities encountered in outdoor illumination are significant.

There are three basic principles of illumination which are recognized as significant in all fields of illumination.[1]

1. Eye comfort and efficiency depend on both the quality and the quantity of light available.

2. Quality of illumination depends on the location and intensity of the light source together with the characteristics of the immediate environment.

3. Good quality of illumination is not possible where extreme brightness differences exist.

For most normal indoor lighting tasks, the visual field and its environment are fairly well defined. Furthermore, by the discreet selection of colors, the boundaries of the visual field can be used to aid in solving the problem of illumination.

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[1] American Association of School Administrators, Twenty-Seventh Yearbook, "American School Buildings," Washington, The Association, 1949, p. 222.

In comparison to the problems of providing illumination for the classroom or gymnasium, those of supplying acceptable illumination for the visual tasks of outdoor recreational activities are more complex.

For purposes of lighting design, most outdoor activity areas may be regarded as huge rooms with black ceilings and walls. The visual field includes the entire area bounded on one side by the activity surface and on the other sides by the extent to which light reaches into open spaces. In determining the size of this area, it is necessary to consult the official rules which determine the horizontal surface dimensions of the playing area, to examine the inherent nature of the activity to determine the magnitude of the visual task, and to consider the circumstances which determine the number and positions of observers for whom adequate illumination is required.

For most typical lighting tasks, the factors which influence light and vision relationships may be assumed to be constant. When these factors are considered for sportslighting, however, they must be recognized as variables. These factors include (1) the object of regard, (2) the observer, and (3) the background.

Object of Regard -- This object, usually a ball, has no fixed location or orientation with respect to the observer. Its size and color, the duration of time of observation and the intensity of such observation, its path, location, and velocity are, for the most part, illusive variables of considerable importance.

Observers -- Observers may include participants, officials and spectators. They have no fixed visual axis or field of view because of the movement of the object of regard, their own movement and the variations in their locations.

Background -- The dimensions of the background are not set, and the problem of providing for an average and a uniform brightness pattern is complicated as a result. The Illuminating Engineering Society states that

> In many sports the normal background against which an object must be viewed by a player comprises all surfaces or space above, below, and on all sides of the player's position. Because a ball or other object may move rapidly through the field of view, the background brightness, if not uniform, may vary rapidly.
>
> With electrical illumination from a few high candle power sources concentrated on an outdoor playing field and filling the space above to a limited altitude only, most of the background area is relatively dark and great care must be taken to be sure that, in addition to providing relatively uniform illumination, the sources are so placed that the number of times a ball must be viewed against them during games is small. [1]

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[1] Illuminating Engineering Society, Illuminating Engineering Society Handbook, New York, The Society, 1947, p. 12-2.

The objectives to be accomplished, and the task of accomplishment is further emphasized in the following statement.

> The objective of sportlighting installation is to control the brightness of the object and the background to the extent that the object will be visible, regardless of its size, location, path, and velocity, for any observer location, path and velocity. In a majority of sports, this objective is achieved by illumination of vertical rather than horizontal surfaces . . .
>
> In many games, a large portion of the playing skill developed by practice is the ability to estimate accurately object location, path and velocity, which vary from play to play. The apparent location, path and velocity of an object are influenced by the object-background brightness relationship and by the angle subtended by the object at the observer's eye. These factors are affected in turn by the uniformity of illumination over the object surface, by the uniformity of illumination throughout the object path, by the object surface reflectance, by the background brightness pattern, and by the observer's location. [1]

Standards for the Design of Floodlight Layouts

Standards for the illumination of outdoor physical education areas are formulated by adapting the fundamental principles utilized in all lighting application fields to the specific problems encountered in this specialized area of illumination. Fortunately, at least two important agencies have done extensive pioneer work in this area, and the standards which they have developed and published provide valuable assistance to groups responsible for designing floodlighting systems. While these standards can be used to advantage in early planning stages, they should not be considered adequate to take the place of the competent illumination consultant or the program specialist when it is necessary to deal with particularly unique problems of a technical nature.

The Illuminating Engineering Society has provided competent leadership in research and education. Its publications, I. E. S. Lighting Handbook, [2] and I. E. S. Recommended Practice for Sports Lighting [3] include basic information on lighting for architects, engineers, designers, and others who plan, manufacture and install lighting systems and equipment. This is a professional agency whose purpose is to further illumination knowledge and to promote a widespread understanding of such knowledge within the illumination profession.

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[1] Ibid., pp. 12-1, 12-2.

[2] Illuminating Engineering Society, I. E. S. Lighting Handbook, 3rd ed., New York, The Society, 1959.

[3] _____, I. E. S. Recommended Practice for Sports Lighting, Prepared by the Committee on Sports and Recreational Area Lighting, New York, The Society, 1952.

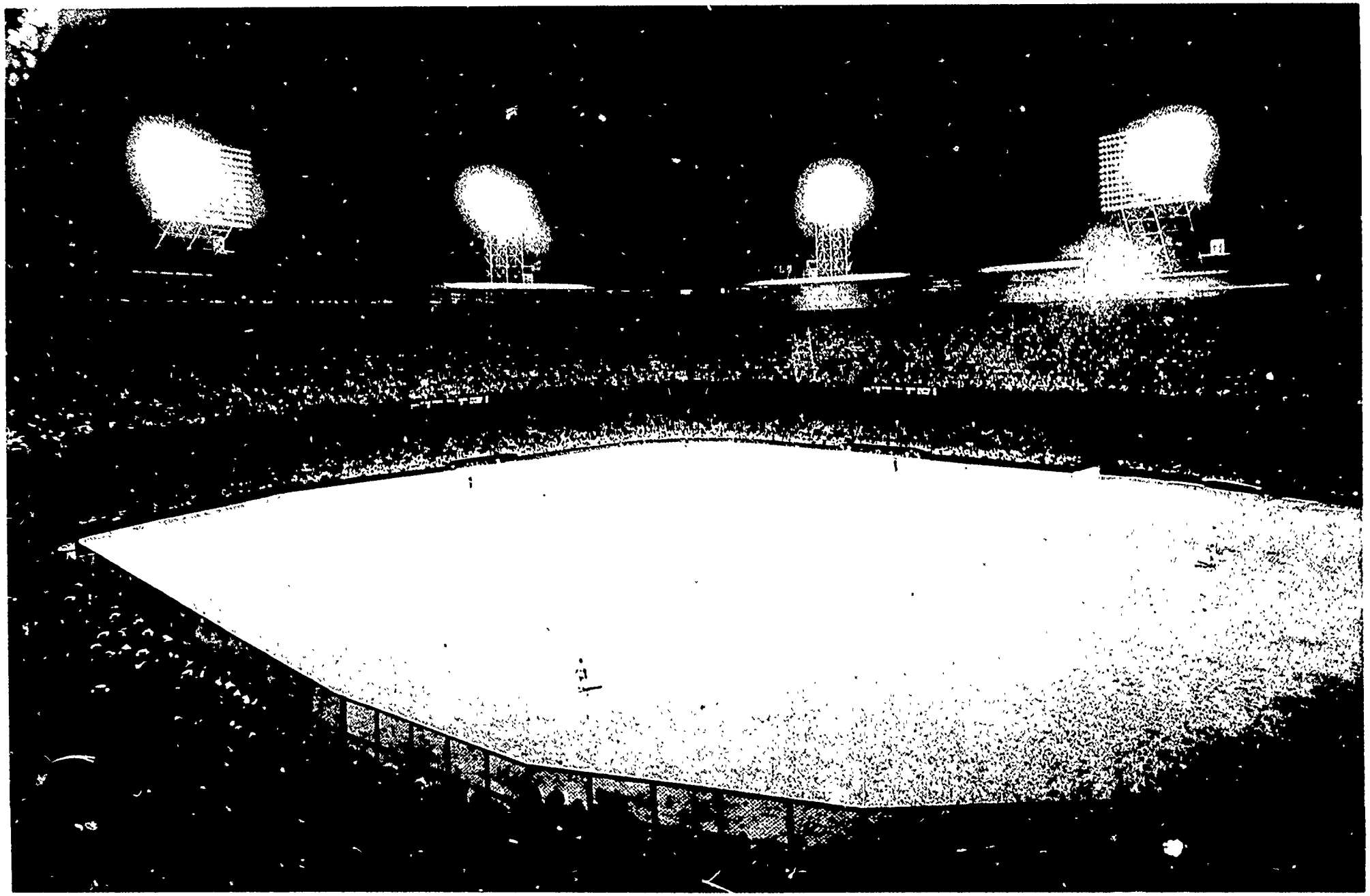

PLATE 11. SPORTSLIGHTING INSTALLATION AT BRIGGS STADIUM, DETROIT, MICHIGAN. Installations may range from the 1328 floodlights in Briggs stadium to a single floodlight in the backyard; all lengthen the recreation day. Courtesy of General Electric Company.

The National Electrical Manufacturers Association[1] is a private agency whose membership includes a wide representation from manufacturers of electrical equipment. The floodlighting section of the NEMA was helpful in the dissemination of knowledge about sports lighting through publication of its report, the National Electrical Manufacturers Association Standard Floodlight Layouts for Floodlighting Sports Areas.[2] This report was adopted as a supplement to A Guide for Planning Facilities for Athletics, Recreation, Physical and Health Education, and has been widely distributed by the Athletic Institute and by NEMA member organizations. This report has since been withdrawn from publication and distribution. To supplement the technical data included in this report, several of the manufacturers of this type of equipment maintain research laboratories and employ competent specialists, distribute detailed plans for floodlight installations and invite inquiries on technical problems.[3] By utilizing the services offered, it is possible to provide excellent conditions for most outdoor sportslighting problems.

In order to utilize this type of material, it is necessary to determine the class of play applicable to the situation under consideration. The long-term view should govern final decisions and should be based on such factors as the skill and age of the players, the number of spectators to be accommodated, and the distance spectators will be located from the field of action. Further considerations take into account the size of the playing field, the minimum mounting heights of the floodlights, and the distance of poles from the field of play.

The information contained in various standard layouts includes the number and size of floodlights required, their distribution and mounting heights, the number, height and location of poles, the kilowatt load, the rated voltage recommended, and the size of the lamp required.

As a further aid in the selection of a floodlighting system, the Illuminating Engineering Society has recommended standards relative to the amount of light required for various physical education activities. These recommendations are reproduced in Table 6.

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[1] National Electrical Manufacturers Association, 155 East 44th Street, New York 17, New York.

[2] _____, NEMA Standard Floodlight Layouts for Floodlighting Sports Areas, New York, The Association.

[3] General Electric Company, Manual of Floodlighting Plans for Sports and Recreation, Schenectady, N. Y., and Crouse-Hinds Company, Floodlights and NEMA Standard Floodlight Layouts, Bulletin No. 2609, Syracuse, N. Y.

TABLE 6[1]

STANDARDS OF ILLUMINATION FOR PHYSICAL EDUCATION ACTIVITIES

Activity		Average Illumination Maintained in Service on Horizontal Playing Surface (footcandles)	
Archery (on target)			
Tournament		10	
Recreational		5	
Badminton			
Tournament		30	
Club		20	
Recreational		10	
Baseball		Infield	Outfield
Major League		150	100
AA & AAA League		75	50
A & B League		50	30
C & D League		30	20
Semiprofessional and Municipal League		20	15
On seats during game			2
On seats before and after game			5
Basketball			
College and Professional		50	
High School		30	
Recreational		10	
Football			
Spectators	Distance from Nearest Sideline		
30,000	Over 100'	100	
10-30,000	50-100'	50	
5-10,000	30-50'	30	
Under 5,000	Under 30'	20	
No fixed seating facilities		10	
Golf Driving Range			
General on tees		10	
On vertical surface at 200 yards		3	
Practice putting greens		10	

[1] Illuminating Engineering Society, Illuminating Engineering Society Lighting Handbook, op. cit., pp. 12-5 through 12-7.

(continued next page)

TABLE 6
(continued)

STANDARDS OF ILLUMINATION FOR PHYSICAL EDUCATION ACTIVITIES

Activity	Average Illumination Maintained in Service on Horizontal Playing Surface (footcandles)	
Handball		
Tournament	30	
Club	20	
Recreational	10	
Horseshoes		
Tournament	10	
Recreational	5	
Rifle Range		
On Target	30	
Firing Line	10	
Soccer		
Professional & College	30	
High School	20	
Athletic Field	10	
Softball	Infield	Outfield
Professional	50	30
Semi-Professional	30	20
Industrial	20	10
Recreational	10	5
Tennis		
Tournament	30	
Club	20	
Recreational	10	
Volleyball		
Tournament	20	
Recreational	10	

It is possible for local planning groups to use the illumination data and standard layout plans available, and on the basis of the facts included to make long-range decisions relative to the selection of floodlight installations for outdoor physical education areas. Such groups should obviously use standards which are applicable to the local situation, and where uniqueness in the local situation is indicated, the illumination specialist should be consulted.

While it is usually desirable to secure the assistance of such specialists early in the planning stages, authorities emphasize that such specialized assistance is

included in the standard layout plans available. Swackhamer[1] believes that practical sportslighting experience has resulted in the adoption of standardized layouts which can be obtained from the manufacturer and utilized by the local contractor in installing the system. However, it is wise to select a manufacturer with a long record of eminent experience in sportslighting, and to enlist the aid of its technical staff at the outset.

Equipment

The equipment needed to provide adequate light for outdoor physical education activities includes floodlights and lamps, poles, and numerous items needed for energizing and controlling the system.

Floodlights -- Floodlights are classified into four principal groupings - heavy duty, general purpose, open, and open with reflector insert - and into several types according to beam spread.[2]

While standard layouts provide data on the type of floodlight to be used, it is necessary for the purchaser to determine whether open or enclosed floodlights are desired.

In making this selection, it is important that the decision be based on a long-term cost and efficiency analysis. Most manufacturers recommend the selection of enclosed lights. While these have a higher first cost than do the open types, they also have a higher lighting output, thus necessitating fewer of them, and they provide longer periods of maximum usefulness with the need for less maintenance and less frequent replacement.

> Experience indicates that open floodlights will drop to as low as 50 per cent of original output in a few months as a direct result of accumulated dust and dirt on lamps and reflectors. Cleaning will restore the combination to 90 to 95 per cent of original output, but deterioration is rapidly repeated. Enclosed floodlights on the other hand will drop to only about 85 per cent during the same period and under the same conditions; and, with thorough cleaning, these floodlights will return to 97 per cent of initial performance.[3]

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[1] R. J. Swackhamer, ". . . And There Was Light," Scholastic Coach, January, 1946, pp. 7, 10, 50-1, 54.

[2] Illuminating Engineering Society, Current Recommended Practice for Sports Lighting, op. cit., pp. 8, 10.

[3] R. J. Swackhamer, "Lighting Outdoor Sports," op. cit., p. 5.

When lamps are to be used over their rated voltage, as they are in most installations in use a relatively small number of hours per year, it is important that they be operated in a "base up" position to reduce blackening and thus increase their light output over a longer period of time. Floodlights selected should be designed so that the lamp is in this position when in operation. Because recent experimentation suggests the future possibilities of fluorescent-type lighting, these possibilities should be considered.[1]

A floodlight should be designed also to permit ease of cleaning and maintenance at mounted heights. Removable socket housing or hinged-glass doors simplify this problem. Because of increased wind velocities at high levels, a floodlight should be small and compact so as to reduce wind load on the pole.

Poles -- The usual mounting heights for sports facilities vary from 10 to 80 or more feet, and wooden or steel poles should be selected which meet requirements as to height and load as indicated by the standards chosen. While there is considerable difference between the initial cost of wooden and steel poles, the advantages gained by use of the latter are such as to make their selection advisable whenever possible. They are neater and more compact; they are stronger thus eliminating the need for guy wires; they last longer; and they lend themselves nicely to underground wiring, to installation on stands or stadia, and to the mounting of lights and safety service platforms.

Wiring -- The merits of underground, as compared to overhead wiring are numerous. The only widely recognized disadvantages have been installation costs and the difficulty of making repairs. Experts now state that the difference in cost can be practically eliminated by careful planning.

> By taking advantage of all the benefits and conveniences afforded by underground wiring and by complete assembly of floodlights on steel poles, together with all branch circuit wiring, before being raised into position, almost all the additional cost of underground wiring can be saved.[2]

By proper selection of underground wiring materials, the need for making repairs can be decreased to the extent that the long-range costs of maintaining this type installation make it a superior investment.

Other Materials -- Materials used for the purpose of regulating and transporting electricity - such as switches, wire, and transformers - are usually specified in the standards for the installation selected on the basis of local requirements and usage. While their selection is a problem for the illumination specialist, since the flexibility with which the system may be used depends on the manner in which it is designed and the materials selected for its control, those who are to use it should specify the qualities desired in such control.

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[1] John S. Haney, "Mercury Vapor Floodlighting - The Key to Year 'Round Sports," Scholastic Coach, January, 1958.

[2] R. J. Swackhamer, ". . .And There Was Light," op. cit., p. 54.

Consideration of Cost

There is considerable evidence to substantiate the claim that sponsorship of athletic contests under floodlights is a sound investment.[1] The increasing use of floodlights in public and industrial recreation programs attests also to the practicability of their use for less highly commercial or revenue-producing activities.

Installation and operation costs for sportslighting for outdoor physical education activities are high. On the other hand, the responsibility of educational institutions for providing worthwhile opportunities in physical education activities for all students and the problems confronted in carrying out this responsibility are considerable also. Sportslighting provides promising possibilities for aiding in the solution of these problems.

On the basis of the brief discussion of the problems of floodlighting included herein, it should be evident that it is impossible to determine costs for systems in general. It is true that the costs of installations vary from an almost insignificant amount for activities which require a low output of light over a small area to almost fabulous amounts for exceptional lighting facilities for the large baseball or football stadia. Because of this, it is necessary to determine cost on an individual installation basis.

The major manufacturers of floodlight equipment have distributors in all regions of the United States. Cost estimates and technical assistance can be obtained from their local representatives. In determining true costs, it is important that the usual principles of economy be observed. It is nearly always a fallacy to select materials solely on the basis of first costs, thus disregarding other long-term principles for economical selection. It is fortunate that most representatives of responsible industry today are interested in aiding the consumer in making wise choices in the selection of merchandise. Frequently, the most important decision to be made is the selection of the firm which is to provide the materials.

Flexible Use of Sportslighting

The amount and quality of service possible in an outdoor lighting system may be markedly increased by early consideration of the possibilities for multiple-use and flexibility of use. Inasmuch as the investment is a considerable one, it is important that maximum returns be assured in the initial design of an installation. Maximum utility is attained by intelligent utilization of equipment, and by foresight in design. Some of the more widely used possibilities for increasing the utility of an installation are enumerated below.

It is possible to provide for multiple-use of a lighting system by good original planning involving the utilization of space. When several activities can be conducted within a given area, a single floodlight installation can be used for each of the activities in turn. When such use is anticipated, it is necessary to consider the level and quality of illumination required for each activity and to build features into the installation which will assure appropriate standards for all.

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1 "Does Floodlighting Pay?", Scholastic Coach, January, 1950, p. 44.
Ralph Piper, "Night Football is Here to Stay", Athletic Journal, April, 1939, pp. 36-38.

It is possible also to plan for the use of a single set of floodlights for activities to be conducted on more than one field. This normally is possible only when the activities for which use is anticipated take place in different seasons of the year. The savings which result from this practice are less than one would expect, however, when the damage to the equipment, the hazards and the work involved are accounted for.

When maximum utility through either of the above methods is to be realized, it is important that possibilities for increasing the flexibility of control and the selection of equipment which lends itself to flexibility of use be considered.

By the use of multiple-wiring, it is possible to build-in a considerable degree of flexibility. When this possibility is fully exploited, individual lights as well as predetermined groups of lights can be turned on or off as desired.

Additional flexibility in use is possible by selecting equipment which can be moved and re-aimed easily. Modern floodlighting equipment can be mounted with a minimum of effort. When a single set of floodlights are to be used at more than one site, extra mounting assemblies should be procured. These can be permanently mounted where needed, and then the detachable reflectors can be moved about as desired. While most modern floodlight equipment is designed for ease and accuracy in aiming, this is a feature of construction which should be looked for.

CHAPTER VIII

SERVICE FACILITIES

In addition to the major problems considered in preceding chapters, there are numerous features which are needed in outdoor physical education facilities to assure their long-term usefulness. These features are classified herein for convenience as service facilities and are categorized according to the specific service they perform: i.e., (1) activity, (2) administrative, or (3) maintenance.

ACTIVITY REQUIREMENTS

Those features found in physical education facilities which contribute directly to their functional validity and efficient utilization by participants are referred to herein as activity requirements. They include backstops and sidestops, goal and net posts, boundary line markings, facilities for the comfort and effectiveness of participants and officials, and many other specialized structures.

Backstops and Sidestops

The official rules for an activity, publications and recommendations of rules committees and recognized promoting agencies, and recommendations of program specialists should be consulted to determine the functional features and specifications of backstops and sidestops.

The official rules for organized baseball specify that an unobstructed space 60 feet in width should be reserved outside each baseline and behind home plate. For softball this requirement is specified to include an unobstructed space 25 feet in width. For tennis, the United States Lawn Tennis Association recommends that backstops be located not less than 21 feet behind baselines and that sidestops be located not less than 12 feet outside the sidelines. The size and detail of construction of these stops, and the location, size and detail of construction of stops for other sports should be determined on the basis of criteria for the safe and efficient promotion of the activity for which they are designed.

The safety of participants, officials and spectators must receive first consideration. While some data are available for the guidance of program specialists, they are frequently expressed in terms of minimum requirements. Frequently there is need for stepping up such recommendations. Chapter 111 outlines detailed recommendations for space requirements for outdoor physical education activities. Backstops and sidestops should be located according to these space requirements, and they should be adequate enough to provide reasonable protection for spectators.

In addition to the protection they afford observers, backstops and sidestops add to the efficient and enjoyable use of a facility by participants. When they are located properly and are of a size which aids in keeping balls, arrows, and other equipment within the space designated for the activity, the time and energy of all groups can be more effectively used and with greater enjoyment.

Backstops can be designed for permanent installation at a specific spot, or they can be constructed as portable or semi-portable installations. Permanent stops are desirable wherever it is possible to locate them in such a way that they will not interfere with any other activity planned for the area. Portable and semi-portable stops can be designed to provide excellent service and to accommodate maximum multiple-use within an area.

While backstops and sidestops can be constructed of wooden posts, the strength, appearance and general utility of the stops are greatly improved when rigid pipe is used to form the framework. Vertical mounting supports can be embedded in concrete footings to assure stability, and standard pipe fittings can be adapted to mount cross supports and to seal pipe openings thus guarding against deterioration resulting from the presence of moisture on unprotected inside surfaces.

Portable backstops which combine qualities of stability and flexibility can be designed when circumstances dictate their use. Backstops which can be moved about as desired are useful for many activities including baseball, softball and field hockey. While it is difficult and impractical to design portability into the larger backstops, it is possible to construct these in jointed sections which can be mounted on wheels and moved about by hand or behind a light automotive vehicle.

The screen material used in the construction of stops should be durable to withstand the shock incurred in normal usage; it should permit spectators seated behind it a good view of the activity; it should be noncorrosive to prevent climatic deterioration; and it should be smooth and free of sharp barbs which could cause damage to equipment. Woven wire fencing of the chain link variety with a minimum thickness of 11-gauge is widely used and highly recommended. The first cost is considerably greater than that for some of the other standard types of wire fence, but it is extremely durable and the high first cost is more than offset by long-term service. Chain link fencing is especially recommended wherever great durability is needed. For use in constructing backstops for baseball, softball and tennis, its rigidity detracts from its desirability. Tennis balls bounce off its surfaces erratically and excessively, and softballs and baseballs are subject to scuffing and marking on contact. Therefore, other types of fencing are more desirable for such activities. They should have rustproof surfaces; they should be smooth and flexible yet strong and durable; and they may be less expensive. Galvanized poultry wire netting, diamond mesh fencing, or linen thread netting such as that used for tennis nets frequently serve the specialized functional requirements of the program better than does the heavier chain link variety.

The size of stops should be such as to decrease the need for retrieving equipment which would be propelled beyond the confines of the playing area were it not for their presence. Naturally it would be impractical to attempt to construct stops of a size which would assure that nothing could get beyond them. Under normal conditions it is recommended that backstops for tennis courts be constructed 12 feet high, for archery they should be from 6 to 10 feet high, and while the dimensions of backstops for baseball and softball will depend on the distance they are placed from home plate and the height of seating facilities behind them, normally they should be from 12 to 40 feet in height.

Backstops for archery should be firm and durable in order to stop an arrow, yet they should be soft enough to minimize damage to it. A long, fine-textured hay, tightly baled and firmly secured with 3 or 4 wires can be utilized to provide an ideal arrow stop. Bales should be bound closely together to prevent the passage of arrows

between them. At least one modern innovation is available in a lightweight, durable yet flexible archery backdrop constructed of fiber and rubber and designed for easy assembling and removal for storage.[1] This is available in 48 by 96 inch sections which are light and easily handled; hanging supports can be designed to permit quick and easy assemblage when they are needed; deterioration and replacement costs are greatly reduced; and they serve the function of the archery backstop very effectively.

Backstops for outdoor rifle and pistol marksmanship can be constructed of armor-plate metal, but when the longer shooting distances are involved it is difficult to construct these large enough to meet requirements. It is more practical, therefore, to locate the target area in front of a natural earth embankment or to construct such an embankment. The dimensions will vary according to the shooting distances involved and the manner in which the area behind targets is to be utilized.

For the discus and hammer throws, backstops should be constructed of sturdy 11-gauge chain link fencing, they should be 6 to 10 feet high, should be located approximately 10 feet behind the rear border of the throwing circles, and should form an arc around the rear half of the circumference of these circles but not extending into the throwing arc.

Goals and Net Posts

The location and size of goal posts, net posts and target supports are specified in the official rules, or they are determined by the size and height of the target or net they are designed to support as specified in the rules. Supporting posts should be strong and rigid. While wood is frequently used, galvanized pipe combines qualities of strength and durability, neat appearance and flexibility of design, and usually serves the program better and more economically.

The permanence of these fixtures depends on the uses to be served by the area on which they are to be located. Goal posts for a football game field should be of strong and permanent construction in order to discourage their destruction by over-exhilarated spectators. When such practices need not be expected, and where possibilities for multiple-use are present, it may be possible and desirable to design semi-permanent fixtures which combine qualities of durability and permanence with those of portability. Capped sleeves embedded in concrete can be installed at desired locations, and the caps can be removed and goal or net posts installed quickly whenever they are needed. Plans for utilizing standard pipe for footings for goal and net posts are shown in Figure 9.[2] Flexibility of use results also when fixtures which serve more than one activity are designed.

Targets for archery usually are supported on wooden tripods which include fittings designed to hold the target so that its center is 4 feet above the ground level. Unless these supports are embedded in the ground and designed to hold the target

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[1] Available from National Park and Recreation Supply Co., South Haven, Michigan.

[2] Details of the removable net and goal posts are reproduced by permission of The City of New York, Department of Parks. Tapered rings, reducing busings and deck plates are available from Vulcan Steel Products Corporation, 234 Varet Street, Brooklyn, N. Y.

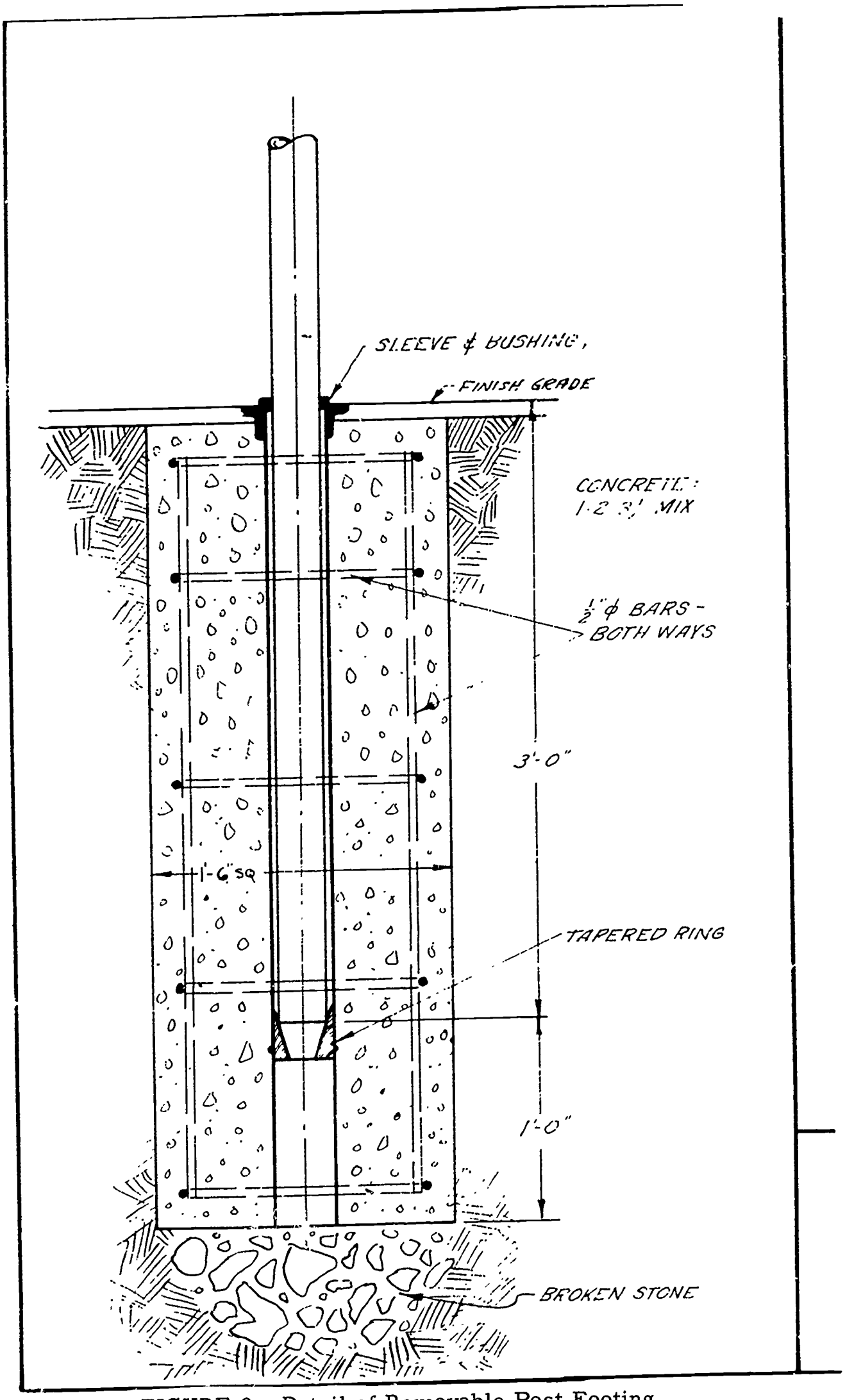

FIGURE 9. Detail of Removable Post Footing.

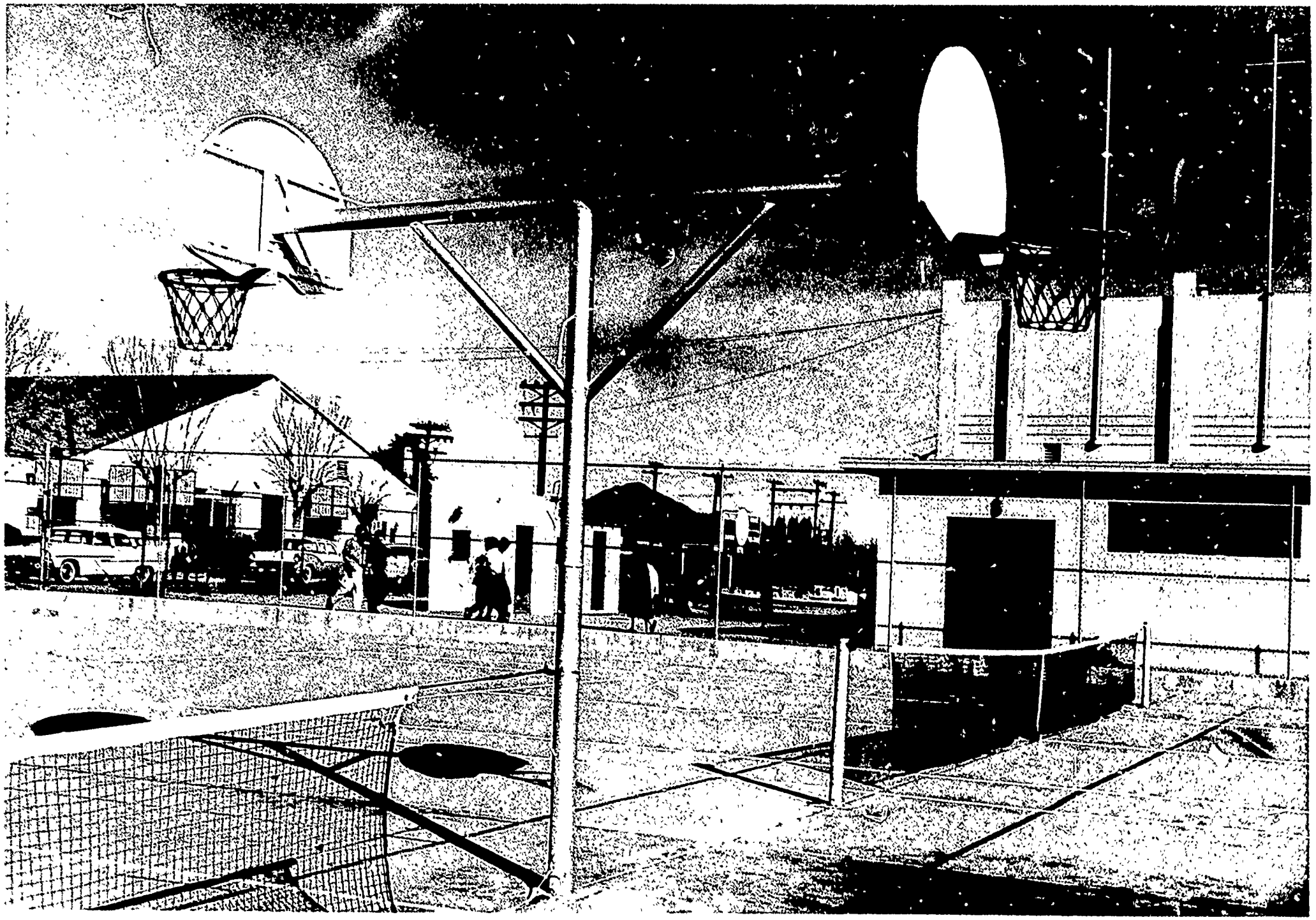

PLATE 12. TWO-WAY OFFSET BASKETBALL BACKSTOP AND TENNIS NET POST. Courtesy of Catherine A. Wilkinson, North Phoenix High School, Arizona.

securely in place, they may be blown over and damaged by a strong wind. Archery target supports can be constructed of wood or pipe, embedded in the ground for stability, and designed to support several targets securely and permanently.

Boundary Line Markings

Official dimensions for physical education facilities can be obtained by consulting the current official rule books for the activities involved. Because these dimensions sometimes change from year to year, the original sources of this information should be used. Descriptions of advanced methods and materials for effecting efficiency and economy in marking these boundary lines usually are not included in such sources.

There is need for improving the methods of marking physical education surfaces in order that boundary lines will be clearly legible at all times without the necessity for continual re-marking. During recent years various methods have been tried with varying degrees of acceptability. These methods aid materially in adding to the validity of physical education facilities and increasing administrative efficiency.

Boundary Lines For All-Weather Surfaces -- For cement and bituminous surfaces, semi-permanent lines can be applied by using a good grade traffic paint. Local and state highway departments have long experience with the problem of selecting and using paint for similar purposes and should be consulted. For general usage, the following specifications describe the composition of paint that should be selected for striping lines on outdoor surfaces.[1]

	White Paint	Yellow Paint
Pigment	60.0%	55.0%
Vehicle	40.0%	45.0%
Pigment Portion		
Titanium Calcium Pigment	70.0%	10.0%
Zinc Oxide	4.0%	4.0%
Zinc Stearate	1.0%	1.0%
Magnesium Silicate	15.0%	45.0%
Diatomaceous Silica	10.0%	10.0%
C. P. Medium Chrome Yellow	0.0%	30.0%
Vehicle Portion		
Varnish	90.0%	90.0%
Thinner (V. M. & P. Naptha)	10.0%	10.0%

Before applying paint, the surface should be thoroughly cleaned by sweeping, scraping or other abrasive action as needed. When paint is to be applied to a recently constructed concrete surface, those surfaces to be painted should be coated with a

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[1]Taken from Standard Specifications for Traffic Marking Paints, State Highway Department, Traffic Division, State of New Mexico.

solution consisting of 3 pounds of zinc sulphate crystals to one gallon of water. This solution should be permitted to remain on the surface for 48 hours, then any crystals which remain should be removed before paint is applied. The paint stripe can be applied either by hand or spray methods, or by an approved striping machine.

Lines on Turf Surfaces -- The usual method of applying lines on turf surfaces is by the use of dry or wet whiting and a portable machine specifically designed for this purpose. Special precautions should be taken to avoid the use of un-slacked lime which causes damage to the skin and eyes of participants. Especially adapted whiting materials which are safe and long-lasting are available and should be used for this purpose.

Since whiting is not permanent and must be re-applied at frequent intervals for continuing results, and because it is not easily applied or seen in thick turf, special techniques are required. When a strip of grass is removed where a line is desired, white lines can be applied quickly and with a minimum amount of whiting; they show up more plainly and they last longer. Grass can be removed for this purpose by close cutting with a narrow "edging cutter", by burning with a torch, or by scraping.

Lines on Clay and Natural Earth Surfaces -- The most widely used method of applying boundary lines to clay and natural earth surfaces is by the use of wet or dry whiting material and a portable marking device. The lack of permanence, however, and the need for frequent remarking has led to experimentation with other methods. Cloth and various non-corrosive metal tapes can be fastened securely to the surface by use of metal staples. Wood planking can also be set into the surface as a more permanent method of handling this problem. Because of the expense involved in the latter methods, whiting still seems to be the most practical means of applying boundary lines to these surfaces.

To aid in the application of lines, it is possible to eliminate the necessity for frequent re-measurement for the purpose of locating the position of such lines by placing a small diameter pipe into the ground with one end flush with the surface. Such pipes can be located at all line endings and intersections. When boundary lines are needed, a chalk line can be stretched between these pipes, and lines can be applied quickly and easily.

Markings for Track and Field Activities -- Preparations for a track meet can be expedited by the installation of permanent markings to show where the starts and finishes for all track events are located, and where hurdles are to be located. These markings can be engraved on bronze plates and embedded in the track curb or they can be painted thereon. Lane markings can be applied by the use of chalk-line and whiting material, a tape measure, and a prepared schedule showing the distances of each line from the inside curb of the track. Such a schedule is of assistance to maintenance personnel in locating the position of lines. The amount of time and labor involved in the application of dry or wet whiting for marking running lanes can be decreased appreciably by an easily designed and constructed device consisting of a small wheel, an adjustable arm and an attachment for securing these to the marker used. The arm can be adjusted to the width desired between lines, and by guiding the extra wheel along one line, the second line can be quickly applied. Marking equipment is on the market which permits applying several lines simultaneously.

Markings for Special Activities -- In addition to the types of line markings suggested above, activities such as archery, baseball, football, golf, rifle and pistol marksmanship, and softball require markings to identify, locate and indicate distances. For football, yard-line markers should be located and constructed to avoid any

possible hazard to players. Flags with flexible staffs should be placed at the inside corners of the four intersections formed by the goal and side lines. Baseball and softball require that extensions of the foul lines be painted on terminating fences, or that foul flags be placed in the outfield on the right and left field foul lines. Archery, rifle and pistol marksmanship, and golf driving ranges should have plainly visible distance markers, and all separate facility units should be numbered for ease of identification and control.

Miscellaneous Facilities

Among the structures and fixtures needed to facilitate instruction and to enhance the program in other ways are those which support equipment, those needed for track and field activities, and those which enable the promotion of activities and instruction of skills in the program.

For Equipment and Supplies -- Facilities designed for football practice should include provision for structures which will support tackling dummies securely and safely. These usually are located in the corners or along the sides of practice and instructional areas in order to minimize interference with other activities in the program. Because of the need for extreme strength, they should be constructed of heavy duty pipe, and they should be designed as permanent installations.

Bat racks should be provided at the dugouts of the baseball and softball diamonds to keep bats from underfoot and enable their speedy identification by players. For other activities, specialized structures and fixtures should be designed and constructed as needed. These should be designed locally by the program specialist with the specific functions to be served determining their size and features of design.

For Track and Field -- The official rules for track and field activities specify dimensions for the take-off board for the broad jump; the planting pit for the pole vault; the shot put stop board; the scratch board for the javelin; the circles for the hammer, shot put, and discus; and the minimum dimensions for landing pits for the pole vault, high jump and broad jump. The major details of construction are, therefore, designated. These items can be purchased or they can be constructed easily and at little expense.

For Specialized Instruction -- For instructional purposes, and for individual practice of specific skills in tennis, soccer, lacrosse, and hockey, a solid wall surface is a valuable facility. When provisions are included for single-wall handball out-of-doors, the wall can be used to good advantage for this purpose. However, such a wall is somewhat more rigid than needed for use in soccer where an inflated ball can be damaged by constant pounding against such a surface. When such a wall is not available, it can be constructed of plank or cement concrete; it need be no higher than 12 or 16 feet, and it can be located to serve as a fence and wind break on the side or end of the facility where located.

Another facility which can be designed to provide many useful services in the outdoor physical education program is the pavilion or shelter. This structure can be simple or elaborate, but should include a roof (for protection from the sun and rain) together with supporting beams or walls. It has many uses in the modern recreation program and can be designed for specialized service in many physical education activities including boxing, wrestling, weight training, gymnastics, and related activities. It can be designed to provide accessible storage space, toilet facilities and to serve other useful functions in connection with the outdoor program.

ADMINISTRATIVE REQUIREMENTS

In order to facilitate the proper administration and supervision of the outdoor physical education program, it is important that facilities designed for the program incorporate features which simplify the problems encountered. Included are service facilities needed by members of the staff, students and officials; for spectator control and comfort; for the press, radio and television; and for the storage of activity equipment and supplies.

Service Facilities for Participants

Services needed for the convenience, comfort and protection of players, instructors and game officials should be provided. These should be located close enough to outdoor activity areas to assure their convenient use.

Facilities for Dressing, Training, and Instruction -- Among the indoor facilities which normally are needed by those who participate in the outdoor physical education program, those listed below are important.

1. Toilet, dressing, locker, shower, and drying rooms sufficient to provide for all students who may be expected to use them.

2. Dressing units for athletic teams including space for dressing, shower, toilet, and towel drying.

3. Auxiliary dressing rooms for use by the faculty, visiting teams and other guests of the department.

4. Staff dressing facilities for use by staff members and game officials.

5. Training and first aid rooms.

6. Lecture rooms for instruction and visual aids.

7. Storage facilities for equipment and supplies.

8. Water and drain outlets for drinking, expectoration, etc.

These should be easily accessible to activity areas and to those who will use them. Entrances should be provided which lead directly from the outside into the dressing rooms, and provisions should be made for the removal and cleaning of athletic shoes at the entrance. Specific detailed standards for these facilities are available.[1]

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[1]Karl W. Bookwalter (ed), College Facilities for Physical Education, Health Education, and Recreation: Standards for Design and Construction, College Physical Education Association, 1947, pp. 60-84.

National Facilities Conference, Planning Facilities for Health, Physical Education, and Recreation, rev. ed., Chicago. The Athletic Institute, 1956, Ch. 4 and 9.

Harry A. Scott and Richard B. Westkaemper, From Program to Facilities in Physical Education, New York, Harper and Brothers, 1958, pp. 245-342.

Players' Benches and Dugouts -- A common means of providing for the comfort of players and staff personnel at the sidelines during athletic contests is by the use of the players' bench. While benches provide for economy and flexibility, there are important reasons for recommending functionally designed covered dugouts for this purpose. For football, soccer, baseball, ice hockey, and lacrosse especially, the dugout provides better protection for the players from the weather, and when it is designed with foresight, many useful provisions including those for first aid can be incorporated. Dugouts should be located well off the playing area in order to reduce visual obstructions for observers and avoid interference with activity on the field. The design of the dugout should include provisions for cleated ramps rather than steps, a sufficient number of comfortable seats for substitutes and team officials, drinking fountain and washing facilities, emergency first aid supplies and equipment, and electrical and communication facilities.

Facilities for Game Officials -- Adequate working space should be provided for scorers and timers. This space should be located strategically in order to enable these officials to observe and record, unhampered by persistent obstruction or interference, the activity which takes place on the playing area. For activities such as football, soccer, lacrosse, and speedball, and for court activities such as basketball and ice hockey, the ideal location is near the center of the playing area on one of the sidelines. For baseball and softball the ideal location is behind home plate, and for net games such as tennis and volleyball, a raised platform should be provided at the net. For track and field activities, a centrally-located sport in the stands or on the infield should be made available.

When an electric scoreboard is used, electrical service connections should be located at the scorers' and timers' table. The board itself should be large enough to transmit vital data to all spectators and participants, and it should be located where it is clearly visible to all.

Spectator Control and Comfort

Where spectators are involved, careful planning is required to assure the convenience and orderliness of their arrival and departure and to provide for their comfort while they remain guests of the organization. The features of special facilities made necessary as a result of such attendance are discussed below.

Roadways and Sidewalks -- If visitors are to arrive at the scene of sports activities safely and conveniently, roadways and sidewalks should be provided which will facilitate travel to and from such destinations. While the problems to be solved in designing and constructing access roadways and sidewalks are technical and within the province of the engineer, some general understanding of these problems should prove useful to the program specialist.

Access roadways should lead directly to parking areas and to passenger discharge points. Such roads should all be well outside of activity areas, with the necessary exception of maintenance drives; they should be designed to complement landscape and traffic control plans for the neighborhood at large; they should be planned in such a way as to force traffic to keep within desired limits; and they should be economical in construction and maintenance.

Sidewalks for pedestrians should follow direct and natural routes. They should be placed far enough away from buildings, fences, roadways, and other structures to permit landscaping, and at all changes of direction or at intersections the angles

should be filled out sufficiently to discourage the normal tendency of people to cut across corners. They should be wide enough to encourage crowds to remain on them (6 to 20 feet wide), they should be completely separated from vehicular traffic, and they should be constructed to safeguard against pedestrian accidents. Where pedestrians are required to cross heavily used traffic lanes, some provision such as an under-pass or an over-pass, or some method of traffic control should be provided.

Parking Facilities -- Vehicular parking is a problem wherever people gather. As such, it requires careful consideration and positive action. Decisions regarding the size, location, arrangement, and control of parking facilities are complex and far-reaching. They should be coordinated with decisions affecting vehicular usage in the immediate and surrounding areas. The following generalities should be considered when making decisions regarding parking problems.

1. While an almost unlimited amount of parking space would be convenient near activity areas in the immediate and long-range future, educational authorities do not necessarily have to provide parking facilities for all the spectators who might attend athletic contests.

2. Parking facilities should be so located as to eliminate the necessity for vehicular traffic within activity areas.

3. Several small conveniently located parking areas will usually provide better accommodations than will a single, larger area.

4. A rule of thumb for determining space needed for parking specifies 300 square feet for each car. One acre of space will accommodate about 160 cars. [1]

5. The arrangement for parking together with a simple and logical plan for entering and leaving the area must be such as to encourage their orderly use. For even the most logical of plans, however, supervision of these areas will be necessary.

6. An all-weather surface which is properly graded to assure efficient drainage provides for long-term, minimum-maintenance parking and can be designed to serve the physical education program for many other uses as well.

Gates and Fences -- The responsibility of administrative agencies to maintain safe and functionally manageable outdoor physical education facilities requires that these facilities be equipped in a manner to effectively close them off to unauthorized users. At the same time, sufficient entrances and exits must be provided to facilitate and control the flow of visitors to and from these areas.

A sturdy fence around the outside boundaries of physical education areas serves many important functions. It establishes boundaries to the area and reduces problems of liability; it protects the property from damage inflicted in unsupervised usage, thus simplifying maintenance; it simplifies problems of supervision and control; it complements landscape design; and it serves to regulate traffic to and from the area.

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[1] Karl W. Bookwalter (ed.), op. cit., p. 108.

While the architectural design for the institution as a whole may dictate the selection of a particular type of fence or wall around the physical education areas, when this is not the case it is generally recommended that a sturdy, non-corrosive chain-link type wire fence be constructed. There are several heights and varieties to choose from, and the use to be served should determine the height and gauge of wire selected. The most widely used fence is constructed of 11-gauge copper steel wire, with a 2-inch mesh. This fencing should be coated after weaving with a heavy covering of zinc by the hot-dip method to give best protection against corrosion. Posts, gates and other parts of the framework of the fence also should be of heavy-duty galvanized steel.

Ordinarily it is undesirable to have barbed wire or sharp, pointed surfaces adjacent to physical education activities where inflated balls are used, because of the possible damage which may be inflicted to such equipment and because of the potential danger to people. However, if the fence is removed some distance from activity areas and if extra precautions are necessary to keep trespassers out, most chain-link fences can be equipped with metal arm-extensions at the posts to which barb-wire can be attached. The top of a chain-link wire fence may have barbed or knuckled selvage depending on the function to be served.

In addition to outside fences, it is frequently desirable to provide secondary fences around activity areas to keep spectators off the playing fields and to isolate different activities. Such fences can be constructed at varying heights and with varying degrees of permanence. Chain-link material can be obtained in several heights from 3 feet up, and where permanence is desired, this type of fencing probably provides the greatest service. The top can be equipped with a toprail and the selvage can be knuckled under to eliminate sharp edges. Because the top and bottom edging can be damaged by stretching through rough and careless usage, a rigid railing at top and bottom is a necessity.

Flexibility in design is frequently desirable in secondary fences. One method of providing such flexibility is by the use of permanent sleeves which are embedded in the ground with the tops set at a level with the surface. Removable posts can be installed easily when the fence is needed, and when not in use, the fence and posts can be removed and stored. The sleeve tops can be covered with caps, and unobstructed play space can be made quickly available. Another method for insuring flexibility for secondary fences is by the use of steel line posts which are equipped with drive plates and eye bolts. These can be driven into the ground wherever they are needed, and rope can be attached to them. Secondary fences should be raised above the ground level so that grass beneath them can be mowed.

Gates should be provided at all entrances and exits as a further means of controlling the use of activity areas. For spectator areas, an efficient control system for admitting visitors should minimize disorder and confusion and prevent delay at the entrance; it should provide for an automatic admission count in order to minimize the problem of gate crashing and other practices favoring free admission; and it should reduce the number of persons required for supervision. Enough exits should be provided to insure the orderly dispersal of all spectators from the area in a maximum period of 10 minutes.

Seating Accommodations -- Wherever large crowds gather to observe sports activities, permanent seating is a long-term necessity. Such seating accommodations should be designed according to rigid specifications and constructed to withstand the hardest of usage. On the other hand, many of the activities in the outdoor physical

education program draw small crowds, and portable or semi-portable bleachers may be utilized to good advantage. The fact that serious seating accidents have occurred, however, attests to the need for extreme caution in the selection, use and maintenance of this type of seating accommodation.

Because there is frequent need for a small number of easily-assembled seats, portable and semi-portable bleachers have a place in the outdoor physical education program. When strict standards are observed in the design, construction, assemblage, maintenance, and use of bleachers, safe and economical service can be expected. The following precautions should be observed.

1. Select and use only those bleachers which have been constructed by a manufacturer with a good reputation of long standing.

2. Specify that the bleachers selected shall conform in design and construction to the legal codes of the state in which they are to be used, and insist on a written statement from the manufacturer specifying the safe load for the stands.

3. Supervise the use of the bleachers to insure against loading them beyond the safe capacity specified.

4. Secure the aid of a reputable engineer to inspect and supervise the maintenance of the bleachers, and see that his recommendations concerning their maintenance and use are strictly followed.

While the quality of materials used and the engineering design of portable bleachers are of first importance, an effective accident prevention and maintenance program is also important.[1] Each part of the bleachers should be inspected according to a predetermined schedule, and such inspection should be made by a person whose testimony of the fitness of the bleachers for the purpose used would be considered authoritative in a court of law.

Wherever seats are more than 4 feet above the ground, a suitable railing should be provided to prevent spectators from jumping or falling to the ground, and aisles should be at least 3 feet wide with no seat more than 25 feet from any aisle. Seats should be spaced not less than 22 inches back to back, and footrests should extend the full width of the opening between seats and not less than 7 1/2 inches in width. Seventeen to 18 1/2 inches in width should be allowed for each seat, and these should be approximately 17 to 18 inches above the footrests.[2] Wooden seats should be designed to withstand the rigors of the climate; they should be sturdy, splinter-resistent and free of pitch-exuding knots.

Comfort Stations and Drinking Fountains -- In addition to the toilet and rest room facilities provided for the use of staff members, participants and game officials, this type of facility should be made available for the comfort of visitors as well. They should be located near seating facilities. Drinking fountains also should be provided. They should be sufficient in number and should be located strategically to assure their accessibility to all visitors.

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[1] Don Cash Seaton, Safety in Sports, New York, Prentice-Hall, 1948, p. 169.

[2] Karl W. Bookwalter (ed.), op. cit., p. 115.

Concession Stands -- If refreshments are to be sold, adequate space and facilities should be made available to permit efficient service. Distribution stands should have electricity for heat, light and refrigeration; an adequate water supply; and space and equipment for preparing refreshments for sale and also for safe and sanitary storage.

Emergency First Aid and Telephone Service -- When large numbers of people gather, accidents must be expected, and the need for emergency care of the first aid variety should be anticipated. A first aid room should be equipped with the supplies and equipment needed for emergency first aid treatment. In addition, a few public telephones should be made available for use by spectators.

Public Address Facilities

The wide use of sound amplification equipment at physical education contests indicates the need for early planning to make possible its availability at any activity where crowds may gather. While the selection and installation of this equipment requires an understanding of the operating characteristics and range of efficiency of various types, its utility will depend to considerable extent on the completeness with which program personnel outline the nature of the use for which it is desired. Plans should include provisions for underground wiring and for a sufficient number of outlets properly located. In determining the location of outlets, consideration should be given to the frequent need for announcers' assistants who may be located at strategic places around the activity area for the purpose of obtaining important game information and relaying it quickly to the announcer.

Adequate working space should be made available for the announcer and his assistants, and this should be located where a clear view of all activity is possible without excessive interference from spectators or participants. Ideal working conditions call for an enclosed announcers' stand to protect this group from the elements and from the noise and confusion of the area. Where this does not seem possible, adequate accommodations can be provided at very little expense.

Facilities for the Press and Radio -- In order to keep the public informed and interested in the physical education program, it is important that representatives of the press, radio and television be encouraged to witness the activities included in that program. Adequate facilities should be provided to enable them to do their work comfortably and efficiently. While few working members of these groups expect elaborate facilities, they all appreciate constructive efforts made in their behalf. For most facilities designed for outdoor physical education activities, adequate provisions for the press, radio and television can be made available simply and at moderate expense. During the planning stages for even the most modest of facilities, however, it is a wise procedure to enlist the aid of radio and television technicians and responsible representatives of the press. In addition to long-term public relations benefits, this procedure is in keeping with the principle that those who use a facility have valuable contributions to make in its design.

Each member of the press will require a comfortable chair and desk space approximately 27 inches above the floor surface, and a minimum of 18 inches deep and 36 inches wide. Drinking and toilet facilities should be easily accessible, and outside telephone service is a necessity. These facilities should be centrally located, but some measure of seclusion is desired to assure an unobstructed view of activity and to minimize confusion and interference.

For still and movie photographers, a flat working space is required which provides a clear view of all activity. Such a space is frequently made available at the top of the press box. It is desirable to provide an elevated site for this type work, yet when considerable additional expense cannot be justified to provide such a spot, photographers probably should be asked to improvise and cooperate to the extent necessary. The increasing practice of taking moving pictures for instructional purposes emphasizes the need for an elevated working space of this nature.

For radio broadcasting, a working space similar to that suggested for sports writers ordinarily is sufficient, but where assistants are required to furnish data for the announcer, this space should be increased considerably. Often the radio announcer, like the public address announcer, will require assistants on the field to relay information to him. This suggests the need for an intercommunication system by which such information can be transmitted. A single system will sometimes suffice for both groups.

In addition to providing for the press, radio and television groups, it is desirable to furnish accommodations for scouts, spotters and other special observers. The usual practice is to provide this space in the press box. Comfortable seats and a working surface are needed. For football spotters, it is desirable to provide a system of communication between the spotter and the players' benches.

Storage Space for Activity Equipment and Supplies

Unless outdoor physical education areas are closely accessible to buildings which provide space for activity equipment and supplies, it is necessary that such space be provided at these areas. This space should be large enough to store equipment and supplies currently or constantly in use. It may also be desirable to provide space for items which are out of season, such as track and field equipment and supplies, nets, posts, archery targets and stands, markers, and other miscellaneous items. Inasmuch as storage space for maintenance equipment and supplies is also needed, it sometimes is possible to design a single structure to serve both purposes. It would probably be worthwhile to provide separate entrances for maintenance and for program personnel, and to partition the areas so as to provide security and privacy.

MAINTENANCE REQUIREMENTS

The efficient maintenance of outdoor physical education areas is made possible by the provision of adequate sources of power and water, space for the storage and repair of maintenance equipment and supplies, and various sundry features which are built into activity facilities and add to the efficiency and ease of maintenance.

Water and Electricty

The maintenance of outdoor physical education facilities requires an abundant supply of water with outlets conveniently located. Plans for providing such a supply of water should be based on a comprehensive study of total water requirements and should show how each need is to be met on a long-term basis. Flexibility in the system is necessary in order to provide for future needs. The water supply for maintenance, drinking, shower rooms, lavatories, concession stands, and for all other requirements can be provided as part of a comprehensive plan.

Water in large volume and at high pressure is required for irrigating turf surfaces, and once this requirement has been determined, plans should be formulated for distributing it where needed. There are several possibilities for assuring adequate

irrigation for turf surfaces, but inasmuch as most educational institutions operate in cycles with near-adequate money and manpower for maintenance available during one period and definite shortages at other times, it is advisable to provide a sprinkling system which is as nearly automatic as possible. Underground piping of adequate size to deliver the necessary quantity of water at sprinker heads is recommended, with the latter located to enable uniform and thorough coverage of all grass areas. The system should be designed so that sections of sprinkler heads can be operated together from a single control box. This box should be covered and equipped with a locking device to discourage tampering by unauthorized persons. When the danger of freezing is present at a locality, it is important that this system be designed so that water can be shut off and drained from all pipes during cold weather. The sprinkler heads and outlets should be flush with the ground, and when in activity areas, they should be rubber covered.

Water is needed for other uses as well, and outlets should be placed where needed around the outside of the running track, near horseshoe pits, adjacent to ice skating and hockey areas when flooding or spraying is required, at the softball and baseball infield, and near court and other special activity areas. All hose bibs should be of non-corrosive metal, and whenever possible they should be located in sunken boxes where they can be locked and packed to prevent tampering or freezing. Drinking fountains should be strategically placed with respect to safety and service, and they should be designed to prevent freezing when this possibility is present.

Electricity also is needed for maintenance, as well as for other aspects of administration. This should be provided as part of the comprehensive development plan. While underground wiring seems desirable for most purposes, for safety reasons alone it should be required adjacent to physical education facilities. A sufficient number of outlets should be provided to meet all needs, and these should be covered to prevent excessive deterioration and to facilitate safety in use. When an electric scoreboard is used, a continuous and uninterrupted flow of electricity is necessary in order to assure proper and continuous functioning of this facility. Because of the unpredictability of the electric loads for other uses such as for concession stands, it is advisable to separate electric lines supplying the scoreboard from those which supply electricity for other requirements. Connections for control switches should be located at the scorers' table.

Storage Space for Maintenance Equipment and Supplies

Storage space for the equipment and supplies required to simplify the maintenance of physical education facilities should be constructed nearby. While provisions for storing such items should be part of the development plan for indoor physical education facilities, it is sometimes desirable to provide a maintenance building in the physical education area for this specific purpose. Frequently such space can be made available in conjunction with that provided for storing physical education equipment and supplies. A roadway should be provided to make this space accessible to motor vehicles.

Built-In Features

By requiring the services of a competent maintenance expert throughout the planning and construction stages, it is possible to design physical education facilities which can be maintained efficiently and economically. When this aspect of administration is slighted, countless errors can result in an increase in the cost and difficulty of maintenance. Whenever extensive hand labor is required in the maintenance of outdoor

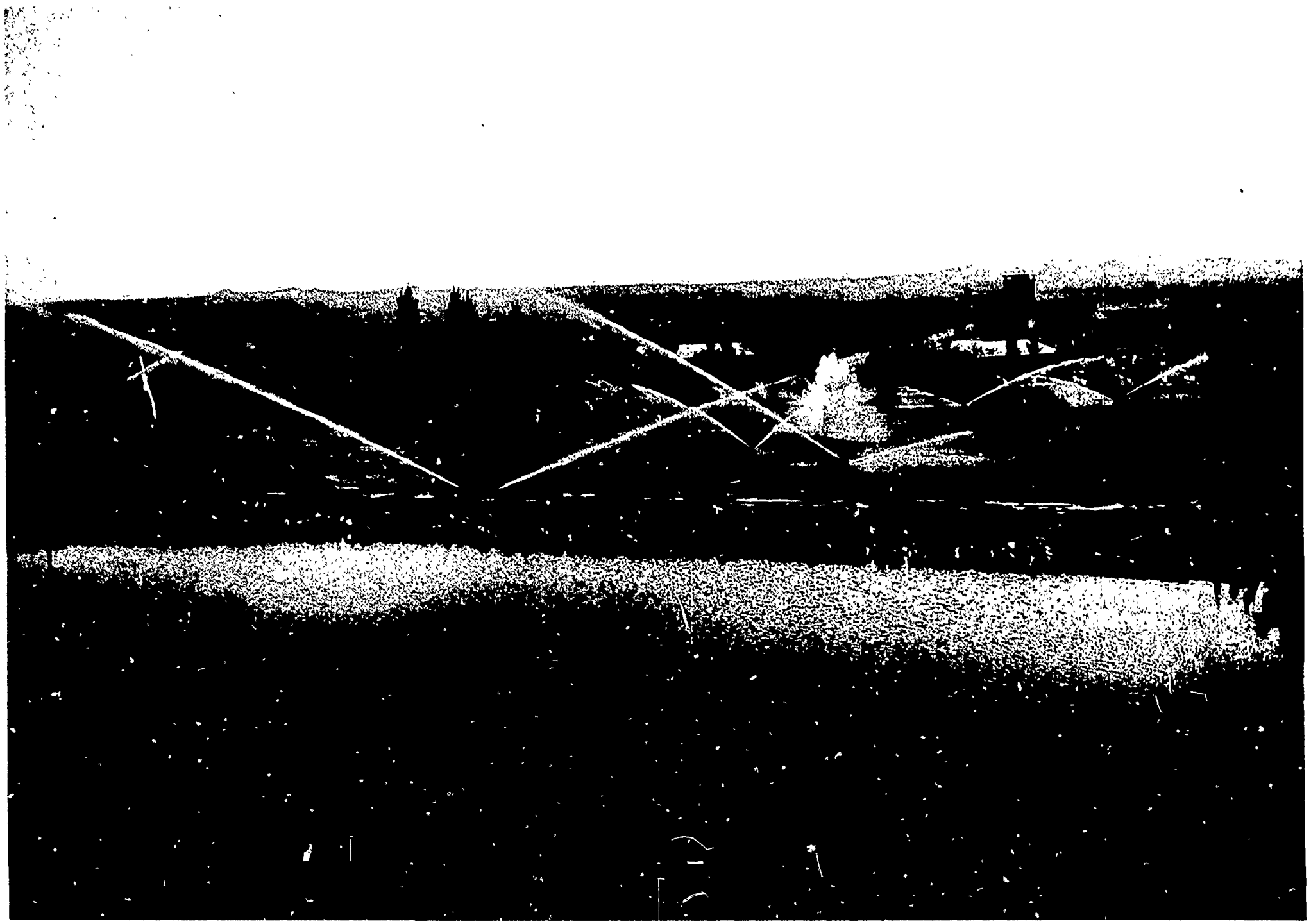

PLATE 13. A GENEROUS SUPPLY OF WATER WITH ADEQUATE PRESSURE AT SPRINKLER HEADS IS A NECESSITY FOR THE DEVELOPMENT AND MAINTENANCE OF TURF SURFACES.

physical education facilities, the task is appreciably increased, and whenever machinery can be used, the task is lessened. Problems of maintenance should be foreseen early in the planning stages, and provisions should be made to eliminate all costly errors in the planning process.

APPENDIX A

SITE STANDARDS FOR EDUCATION AND RECREATION[1]

I. Site Standards For Community Recreation

Standard: One acre for each 100 of the total population of the community distributed as follows:

A. The Play Lot: For use by pre-school children of the immediate neighborhood, i.e., the housing development.

Standard: 2,000 to 5,000 or more square feet
25 to 50 or more square feet per dwelling

B. The Neighborhood Playground: For use by school age children and adults of the immediate neighborhood.

Standard: 4 to 7 or more acres for each playground
1 acre for each 800 of total population
50,000 square feet for each housing development of 100 dwellings plus 120 square feet for each additional dwelling (deduct 300 square feet for each dwelling under 100 in the development).

C. The Community Playfield: Playfields to serve the entire community.

Standard: 12 to 20 or more acres
1 acre for each 800 of total population

D. The Community Park:

Standard: 25 acres minimum recommended
200 acres or more for the community of 40,000 population

II. Site Standards Applicable to the Community Education Program

A. The Elementary School: To serve a geographical radius of 1/4 to 1/2 mile.

Standard: 15 acres or more.

B. The Junior High School: To serve a geographical radius of 1/2 to 1 mile.

Standard: 25 acres or more.

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[1] These standards represent gross national estimates of local requirements. They are valuable in the struggle to raise deplorably low local standards, but should in no instance be used to restrict local initiative to do even better.

C. The Senior High School: To serve a radius of 1 to several miles.

Standard: 40 acres or more.

D. The Consolidated School: Including grades 1 through 12.

Standard: 40 acres or more.

III. Standards Applicable to the Larger Community for Specific Facilities.

A. Baseball Fields: 1 for each 6,000 of total population

B. Softball Fields: 1 for each 3,000 of total population

C. Tennis Courts: 1 for each 2,000 of total population

D. Swimming Facilities:

Outdoor: 12 square feet per person on the basis of 3 per cent of the total population.

Indoor: 1 pool for each 50,000 of total population

E. Gymnasiums: 1 large for each 10,000 of total population

F. Auditoriums: 1 for each 15,000 of total population

G. Recreation Center: 1 for each 5,000 of total population

H. Golf: 1 hole for each 3,000 of total population

APPENDIX B

DETERMINING THE AZIMUTH OF THE SUN

The mathematical methods by which the azimuth of the sun can be computed are illustrated as they are utilized in solving a practical problem of orientation for a sports activity.

THE PROBLEM

Determine the azimuth of the sun and interpret the findings as they would be used in planning for ideal orientation for football for a site located at Manhattan, Kansas. The average period of maximum use occurs on October 27 at 3:15 p. m.

THE BASIC FORMULA AND COMPUTATIONS

The following basic formula can be used for computing the azimuth of the sun when the declination is of a minus quantity. A second formula must be used if the declination is of a plus quantity. [1]

$$\text{Cos } Zs = \frac{\text{Sin d}}{\text{Cos h Cos L}} - \text{Tan h Tan L}$$

The latitude (L) can be determined by consulting any large map of the United States; the declination (d) can be determined by consulting any solar ephemeris and corrected for time as in Computation II; and, the altitude of the sun (h) can be determined as in Computation III. The sine, tangent, and cosine of an angle can be found in any table of natural trigonometric functions.

THE AZIMUTH OF THE SUN COMPUTED

$$\text{Cos } Zs = \frac{\text{Sin d}}{\text{Cos h}\quad\text{Cos L}} \_\_\_ \text{Tan h Tan L}$$

$$= \frac{-.22045}{.92336\quad .77439} \_\_\_ .41570\ \ .81703$$

$$= -.64794$$

$$= S\ 49^{o}\ 36'\ 11''\ W$$

Basic Data Used:

Declination (d) is 12^{o} 44'07.55". Sin d = -.22045 (See Computation II).
Altitude (h) is 22^{o}34'35". Tan h = .41570. Cos h = .92336. (See Computation III).
Latitude (L) is 39^{o}15'N. Cos L = .77439. Tan L = .81703.

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[1] Gourley Ephemeris for the Sun and Polaris, 1951. p. 37.

Intrepretation of Findings:

The bearing given as Zs is the line on which the football goal and yard lines should be located in Manhattan, Kansas to provide the best possible orientation with respect to the sun, and is perpendicular to the side lines.

Computation I: Time Determination[1]

	h m
Clock reading at 96°36' West Longitude	$3^h\ 15^m$
This reading is in the sixth time zone	$+6^h\ 00^m$
	$9^h\ 15^m$
It is an afternoon reading	$+12^h\ 00^m$
Greenwich Mean Time	$21^h\ 15^m$

Computation II: Declination[2]

Declination for October 28 at $24^h\ 00^m$ is	$-12^\circ\ 46'\ 26.6''$
Difference for one hour (- 50.562")	
Difference for 2.75 hours	$2'\ 19.05''$
Declination for $21^h\ 15^m$	$-12^\circ\ 44'\ 7.55''$

Sine d = .22045 Cos d = .97540

Computation III: The Altitude[3]

Sin h = Sin d Sin L + Cos d Cos L Cos t (hour angle).
= (-.22045 .63271) + (+.97540 .77439 .69257)
Sin h = +.38265
h = 22° 34' 35" Cos h = .92336

Computation IV: The Hour Angle (t)

Greenwich Mean Time	$21^h\ 15^m$
Equation of Time (Computation V)	$+\ 16^m\ 03.67^s$
Greenwich Apparent Time	$21^h\ 31^m\ 03.67^s$
Longitude expressed in Time	$-\ 6^h\ 26^m\ 24^s$
Local Civil Time	$15^h\ 4^m\ 39.67^s$
An afternoon reading	$-12^h\ 00^m\ 00.00^s$
Local Apparent Time	$3^h\ 4^m\ 39.67^s$
Expressed in Arc[4] = 46° 09' 55.5".	Cos t = .69257

[1] Ibid, 47
[2] Ibid, 66
[3] Ibid, 37
[4] Ibid, 67

Computation V: The Equation of Time

Equation of Time for October 28[1]	$16^m\ 04.24^s$
Difference for 1 hour ($.208^s$)	
Difference for 2.75 hours	$.57^s$
	$16^m\ 03.67^s$

Equation of time for October 27, $21^h\ 15^m$

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[1] Ibid., p. 47.

APPENDIX C

THE PHYSICAL EDUCATION PROGRAM SPECIALIST'S BUILDING MANUAL

1. File Entries For the Physical Education Building Manual.[1]

Section A: Comprehensive Planning for Plant Development

1. Planning Procedures
2. Planning Consultants
3. Institution -Wide organization (Include under this sub-topic a file entry for each functioning group and for each function included within this organization).
4. Plant Development Documents
    a. The Master Plan
    b. Official Maps

Section B: Common Problems File

1. Site Selection
2. Drainage
3. Grading
4. Illumination (Indoor)
5. Illumination (Outdoor)
6. Landscape Design
7. Orientation
8. Physical Education Surfaces
    a. Bituminous
    b. Cement Concrete
    c. Other All-Weather Surfaces
    d. Natural Earth
    e. Quick-Drying
    f. Track
    g. Turf
    h. Wood
    i. Miscellaneous

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[1]The Building Manual as herein described utilizes a metal filing cabinet and letter-size file folders. The entries included are merely suggestive of those which the Physical Education Program Specialist should include to enable him to file for handy reference the ideas, photographs, sketches, descriptions, and other information he will need in carrying out his responsibility in the functional design of physical education facilities.

Section C: Special Functions File

1. Backstops
2. Fences
3. Irrigation
4. Locker Room
5. Shower Room
6. Equipment Room
7. Miscellaneous Equipment
8. Miscellaneous Fixtures
9. Marking Outdoor Fields & Courts
10. Marking Indoor Fields & Courts
11. Parking
12. Playground
13. Press, Radio, Television
14. Safety
15. Seating for Spectators

Section D: Activities File

1. Archery
2. Badminton
3. Baseball
4. Basketball
5. Boxing
6. Bowling
7. Dual Activities
8. Camping
9. Combatives(Miscellaneous)
10. Corkball
11. Dancing - Rhythmics
12. Fencing
13. Field Hockey
14. Fishing Activities
15. Flickerball
16. Football (11-man)
17. Football (Touch-Flag)
18. Football (6-man)
19. Games (Miscellaneous)
20. Golf
21. Gymnastics
22. Handball
23. Horseshoes
24. Ice Hockey
25. Ice Skating
26. Lacrosse
27. Marksmanship (guns)
28. Multiple-Use Areas
29. Playground Activities
30. Roller Skating
31. Rogue
32. Shuffleboard
33. Skiing
34. Soccer
35. Softball
36. Speedball
37. Swimming and Diving
38. Tennis (lawn)
39. Tennis (paddle)
40. Tennis (various)
41. Tetherball
42. Track Events
43. Track & Field (Field Events)
44. Tumbling
45. Volleyball
46. Weight Training
47. Wrestling